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URBANA

REPORT OF INVESTIGATIONS—NO. 57

FINE-GRAINED MOLDING SAND RESOURCES OF NORTHERN ILLINOIS

A Preliminary Investigation

BY

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FINE-GRAINED MOLDING SAND RESOURCES OF NORTHERN ILLINOIS

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SUMMARY

Large quantities of fine-grained molding sand are used annually in the Chicago area in the manufacture of nonferrous, malleable, and small gray-iron castings. Most of this sand is produced at a considerable distance from Chicago. This report gives the results of a preliminary investigation to determine whether or not deposits of suitable sands more favorably located with reference to the Chicago market could be found in northern Illinois. The sands which it was hoped to duplicate in Illinois are of two principal types:

(1) Albany, New York, sand, especially grades 00, 0, and 1. These sands have grain fineness numbers between 150 and 250. The coarsest usually do not contain more than 10 per cent of grains coarser than a 70-mesh sieve, and the finest do not contain more than 50 per cent of pan material.

(2) Sands with grain fineness numbers of 250 to 300 and containing 60 to 85 per cent of pan material. These sands are produced together with other grades of sand in southern Indiana, northern Kentucky, and central and northern Ohio. Sand of this grain size has no general name and for convenience is referred to in this report as the Southern Indiana sand.

Illinois deposits of sand, similar in grain size to the Albany sands, were found near Morrison, Lyndon, Denrock, Fenton, and Garden Plain in Whiteside County; near Aiken and Rice in Jo Daviess County; near Mason City in Mason County; near Colona in Henry County; and near Milan in Rock Island County. One deposit near Lansing in Cook County is a possible source of fine-grained molding sand although it does not have the same grain-size distribution as the Albany sand.

The most promising deposits of sand similar to the Southern Indiana sand were found near the Mississippi River bluffs in Rock Island, Whiteside, Carroll, and Jo Daviess counties.

Sieve analyses are given of numerous samples from deposits in Ford, Grundy, Iroquois, Kankakee, and Will counties. The samples represent the finest grained sands found in these counties but they are all coarser grained than the Albany No. 1 sands. Numerous deposits were also examined in Bureau, Kane, La Salle, Lee, McHenry, Marshall, Ogle, Peoria, Tazewell, and Winnebago counties.

Sieve analyses are reported on 138 of the samples taken during this investigation. Of the samples 42 have grain fineness numbers within the range of the Albany No. 00 to No. 1 sands, and 37 have grain fineness numbers within the range of the Southern Indiana sands. Many of these, however, are unlike the Albany or Southern Indiana sands in distribution of grain size or in clay content.

Of the most promising deposits, 12 of the Albany type and 3 of the Southern Indiana type of sand were selected for more detailed studies. In green compression and permeability several of the samples are in close agreement with the Albany and Southern Indiana sands.

Mineralogical examinations indicate that the Illinois sands are similar to the Albany and Southern Indiana sands in consisting largely of angular and subangular grains of quartz. Microscopic and X-ray studies of representative samples show that the clay minerals in all three sands consist largely of the clay mineral illite. However, some difference apparently exists in the variety of illite, and this may account for the comparatively high green compressive strengths obtained on some of the samples of Illinois sands.

INTRODUCTION

Large quantities of fine-grained molding sands are used in Illinois, particularly in the Chicago area, in the manufacture of nonferrous, malleable, and small gray-iron castings. Most of this sand is produced a long distance from Chicago. The principal source is the Albany, New York, district, but fine-grained sand is also shipped to Chicago from southern Indiana, Ohio, Kentucky, and Tennessee. The value of the Albany sand used yearly in the Chicago district has been variously estimated; some estimates are as high as $500,000. The price of the Albany sand in Chicago is about $12.00 per ton in small lots from supply houses or about $6.25 per ton in carload lots.

Molding sand is relatively low priced. In 1936 the price of molding sand produced in the United States averaged about $1.00 per ton at the pit,[1] but some sands, such as the Albany molding sands, command a price higher than the average. The price of the Albany sand at Albany in 1938 was about $2.00 per ton.

When molding sand is shipped any great distance, the cost of transportation is a major part of the delivered price. The rail distance from Chicago to Albany is about 800 miles, whereas the maximum distance from Chicago to any sand deposits described in this report is about 180 miles and many deposits are closer. The freight rate for Albany sand from Albany to Chicago is $4.29 per ton in carload shipments. This affords any suitable Illinois sands a substantial freight differential over the eastern sands and might permit processing or blending of Illinois sands without removing them from a competitive price position.

The rail distance from Chicago to Evansville, Indiana, is about 285 miles, which gives the northern Illinois sands an advantage of 100 miles or more over the southern Indiana sands.

As any fine-grained molding sand in northern Illinois would have an advantageous location with reference to the Chicago market, an exploratory investigation was made to locate possible deposits of sands of this type and to obtain preliminary data regarding their probable extent and character. The results of the study are given in this report.

Several sands were found which are similar to the sands now used. Their commercial exploitation is not recommended, however, until the deposits have been thoroughly explored to determine their size and the character of the sand, its possible uses, and potential markets.

The emphasis in this investigation was directed primarily toward the discovery of deposits of sand similar in grain size to the Albany and Southern Indiana sands. However, the increasing use of synthetic molding sands suggests that other types of fine-grained sands may be of potential value for the preparation of such synthetic sands by washing, screening, or crushing, or by blending with other sands. The comparative scarcity of fine-grained sands suitable for use in synthetic mixtures in part accounts for the fact that synthetic molding sands have not replaced more extensively the natural fine-grained molding sands.

Deposits representative of all the various major classes of fine-grained sand deposits in northern Illinois are believed to be included in this report although it was not possible to cover all individual deposits. The report, therefore, serves as a basis for more detailed work in any area wherein the location of additional deposits is of special interest.

Procedure

The search for fine-grained molding sands in northern Illinois involved, first, the use of the general fund of geologic knowledge which the Survey has accumulated regarding the distribution and character of sand deposits and, second, a search for sand deposits the origin of which was similar to that of the Albany and Southern Indiana sands. The Albany sands are known to have been deposited in a large lake which occupied Hudson River valley in Glacial time. Therefore, many of the areas of Illinois which were also occupied by lakes during Glacial time were examined for similar deposits, as well as many of the terrace areas along rivers which during Glacial time were swollen to the proportions of lakes.

The fine-grained Southern Indiana molding sand is probably mostly "loess," which is wind-deposited silt. Material of similar composition and texture also may be laid

[1] Hughes, H. H., and Egge, G., Sand and gravel: U. S. Bur. Mines Minerals Yearbook, 1938, p. 1070.

down in lakes or in the slack waters of rivers, and some of the Southern Indiana sand may be of this origin. The similarity of the Southern Indiana sand to loess suggested that the loess deposits of northwestern Illinois might be a source of similar materials, particularly the sandy loess near the major valleys.

The field work included the examination of outcrops in road cuts and along streams, supplemented by auger borings in some of the more favorable areas where there were no outcrops. As the study was only preliminary, specific deposits were not examined in detail. Although not all of the many areas of lake deposits were studied, enough data were collected to indicate the general character of the fine-grained sands in northern Illinois.

Samples of about 5 pounds were taken from the outcrops or auger borings and were brought into the laboratory where the grain size of the sand was determined according to the methods of the American Foundrymen's Association. Tests were made on 138 samples. On the basis of the grain-size data on the small samples, together with information regarding the probable size, uniformity, and availability of the deposits, 15 deposits were selected as being the most promising. These 15 deposits were revisited and representative samples of about 50 pounds were collected.

The large samples were tested for grain fineness, clay content, green compressive strength, and green permeability. The same tests were made on samples of Albany No. 00 and No. 1 sand obtained from a supply house in Chicago, and on an Evansville sand submitted by a southern Indiana company. Tests were made according to the specifications of the American Foundrymen's Association.[2] Tyler Standard sieves corresponding in size of openings to the U. S. Standard sieves were used for the screen tests. A Simpson muller-type laboratory mixer was used in tempering the sands. The compression and permeability tests were made with a Dietert universal sand strength machine and a Dietert permeability meter.

Acknowledgments

This investigation was made under the supervision of J. E. Lamar, Geologist and Head of the Industrial Minerals Division of the Survey. Cove Heilbronner, research assistant, aided in the field and laboratory studies.

M. M. Leighton, Chief of the Survey, and G. E. Ekblaw aided in selecting promising areas for investigation, R. E. Grim checked the petrographic identification of the clay minerals, W. F. Bradley made X-ray determinations of the clay minerals, and O. W. Rees supervised the chemical analyses of sands.

C. E. Schubert, of the Mechanical Engineering Department of the University of Illinois, permitted the use of a Dietert permeability meter.

CHARACTER OF FINE-GRAINED MOLDING SANDS

The fine-grained molding sands considered in this investigation usually contain more than 75 per cent of grains smaller than 100 mesh and have grain fineness numbers higher than 150. It was hoped especially to duplicate two types of fine-grained sand: (1) that produced in the Albany, New York, district, and (2) that produced in southern Indiana. In order to provide a means of readily comparing the sands, the Albany and southern Indiana sands are briefly described.

Albany Sand

An area extending for 100 miles along Hudson River valley and centering about Albany, New York, has been one of the principal sources of molding sand in the United States for many years, and sand from this district has been shipped as far as the west coast. The Albany sands have been described in detail by Nevin[3] and the following summary is based on his work except where noted otherwise.

Origin.—During late Glacial time there was a large lake in the area now occupied by Hudson Valley. At a time when the margin of a glacier was near the lake, streams flowing from the melting ice carried large quantities of sand into the lake, and the sand was deposited where the currents of the streams were checked. The sand consisted largely of quartz grains but contained many grains of shale and metamorphic rocks picked up by the glacier from the bedrock in the vicinity of the deposits as well as from areas to the

[2]Testing and grading Foundry Sands and Clays, Standards and Tentative Standards, Am. Foundrymen's Assn., 4th Ed., 1938.

[3]Nevin, C. M., Albany molding sands of the Hudson Valley: New York State Mus. Bull. 263, 1925.

Table 1.—Variation in Grain Size of Albany Sand by Grades[1]

Per cent on sieve	Grade Number											
	00		0		1		1½		2		3	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
6	—	—	—	0.3	—	—	—	0.1	—	0.3	0.2	0.8
12	Tr	0.4	—	0.4	—	0.2	—	0.8	0.1	1	0.7	3
20	0.1	0.2	Tr	0.2	0.1	0.2	Tr	0.6	0.1	3	1	3
40	Tr	0.3	Tr	0.5	0.1	1	0.5	2	0.8	10	2	23
70	0.4	2	0.6	4	0.5	10	11	27	23	57	32	64
100	0.8	3	1	5	7	17	8	26	8	21	3	7
140	2	6	2	18	11	29	5	18	4	13	2	3
200	5	13	4	22	11	25	6	14	3	9	1	3
270	19	32	16	29	16	22	6	18	3	12	2	6
Pan	33	48	17	47	14	24	6	29	6	22	5	12
Clay	13	27	8	22	4	24	5	17	7	15	9	16
Grain fineness number	215	240	175	245	150	185	105	175	75	140	60	95
Number of samples	6		13		8		8		13		7	

[1]After Nevin, C. M., Albany molding sands of the Hudson Valley: New York State Mus. Bull. 263, pp. 30, 36–49, 1925.

north. Later the lake drained away and the present channel of Hudson River was cut down through the lake deposits. Consequently the sands now occur high above the river in extensive flat areas, called terraces, which are remnants of the old lake bottom. After the lake disappeared, the sands were exposed to weathering processes which have continued to the present time and have developed a soil covering on the deposits. Rain water percolating downward through the sands broke down the fragments of shale into small particles of clay, decomposed the metamorphic rocks into clay and sand, and distributed the clay through the sand. The zone in which the clay occurs is the molding sand. Below it the sand is "sharp" and contains little bond.

Thickness.—The average thickness of the molding sand deposits is 15 to 20 inches but the thickness ranges from a few inches to a maximum of about 8 feet. The overburden consists of 10 to 12 inches of soil.

Grades.—The Albany molding sand is marketed under six principal grades based on the coarseness of the sand and ranging from No. 00, the finest grained size, through No. 0, No. 1, No. 1½, No. 2, No. 3 to No. 4, the coarsest. The extreme grades, Nos. 00 and 4, are less common than the others. The separation of the different grades is difficult as all grades from No. 0 to No. 3 may be found in an area no larger than an acre. Abrupt changes in grade are common and follow no set rule. The grade terms are not uniformly used by different producers although the variations are usually not more than a single grade. After a study of many samples, Nevin devised a method of grading on the basis of grain size which eliminated a considerable overlapping of the grades and indicated the average usage of the grade terms. The extent to which the grade terms overlap in actual practice was shown by the fact that in making this classification it was necessary to change the grade number of 20 out of 54 samples which had been submitted by a number of producers as their standard grades. The range in amounts of grains retained on each sieve for each grade is given in table 1, and the average grain size for each grade is given in table 2.

Most of the Albany sand shipped into Illinois falls into grades 00, 0, and 1. These are briefly described below:

Table 2.—Average Sieve Analyses of Albany Sand by Grades[1]

Per cent on sieve	Grade Number					
	00	0	1	1½	2	3
6	—	Tr	—	Tr	0.1	0.5
12	0.2	0.1	Tr	0.3	0.4	2
20	0.1	0.1	Tr	0.2	1	2
40	0.2	0.3	0.4	1	5	13
70	1	2	4	19	37	50
100	2	3	11	18	15	5
140	5	9	20	13	9	2
200	8	13	16	9	5	2
270	23	24	18	12	7	3
Pan	40	34	18	14	10	8
Clay	21	15	12	13	11	13
Number of samples	6	13	8	8	13	7

[1]After Nevin, C. M., op. cit. pp. 30, 36–49.

No. 00 grade.—The No. 00 grade is the finest grained grade of Albany sand. Its grain fineness number ranges from 215 to 240, according to analyses of six samples studied by Nevin. The clay content ranges from 13 to 27 per cent and averages 21 per cent. These sands have a large proportion of pan material and 270-mesh sand, usually totaling 60 to 70 per cent (table 1). They contain less than 10 per cent of sand coarser than 140 mesh. The permeability ranges from 7 to 13, averaging 9, and the maximum cohesiveness ranges from 176 to 203 at 6.0 to 8.7 per cent water. The sample of Albany No. 00 grade sand tested in this investigation has a grain fineness number of 225 but does not exactly meet the requirements of the classification. It is about 6 per cent too low in 270-mesh grains, 5 per cent too high in 200-mesh grains, and has slightly more than 10 per cent of grains coarser than 140 mesh. In grain size it is more like the No. 0 grade as defined by Nevin. This sample has, at 5.9 per cent water, a green compressive strength of 9.3 pounds per square inch and a permeability of 11.1. Other tests of Albany No. 00 sands are given in table 3.

No. 0 grade.—The No. 0 grade of Albany sand as defined by Nevin includes a long range of grain size and almost completely overlaps the No. 00 grade sand (table 1). The 13 samples he studied have grain fineness numbers from 175 to 245. The average sand in this grade contains a little less pan material and more 200-mesh sand than the average No. 00 sand. Sands at the coarse end of this grade contain much less pan material than the No. 00 sand and also have roughly equal distribution of the sand on the 140-, 200- and 270-mesh sieves. They contain less than 10 per cent coarser than 100-mesh. The permeability of No. 0 grade samples tested by Nevin ranges from 8 to 22 and averages 13, and the maximum cohesiveness ranges from 133 to 251 at 6 to 11.9 per cent water. Two samples of Albany sand studies by Freeman[4] had been designated as No. 0 and No. 1 although they were similar in grain size as shown by the grain fineness numbers of 214 and 217. Both were No. 0 sands in Nevin's classification. One had a permeability of 10.2 and a green compressive strength of 5.7 pounds per square inch at 6.1 per cent water and the other a permeability of 15.3 and a green compressive strength of 3.2 at 6.0 per cent water. Tests of typical Albany No. 0 grade sands are given in table 3.

No. 1 grade.—The No. 1 grade of Albany sand includes sands with grain fineness numbers of 150 to 185, as shown by 8 samples studied by Nevin. They generally contain a little less clay than the finer sands

[4]Freeman, C. H., Natural bonded molding sands of Canada: Canada Dept. of Mines, Mines Branch, No. 767, p. 131, 1936.

Table 3.—Tests of Albany,

Sample number	Grade	Source[1]	Sieve Analysis, Per Cent								
			6	12	20	30	40	50	70	100	140
209.......	00	A		0.14	0.06		0.26		1.16	1.28	2.26
254.......	00	A		0.26	0.12		0.32		0.86	2.44	5.88
A00.......	00	B				Tr	Tr	0.2	0.4	3.6	6.8
207.......	0	A	0.30	0.38	0.18		0.30		2.12	4.92	8.50
244.......	0	A		0.02	0.02		0.02		2.48	4.02	13.30
	0	C		0.08	0.10	0.09	0.15	0.66	2.29	4.26	6.75
369.......	1	A		0.20	0.16		0.36		2.36	11.08	20.34
260.......	1	A			0.10		0.40		1.88	10.24	27.12
A1........	1	B				0.6	0.4	1.0	2.0	15.6	21.4

[1]Source:

A—Nevin, C. M., op. cit., pp. 70–77. This report contains many other tests of Albany sand. The tests quoted are of sands which had the same grade in Nevin's classification and in the trade designation of the producer.

B—Samples from a supply house in Chicago; grades are trade designation; exact source unknown; tested in present investigation.

C—Freeman, C. H., op. cit. p. 131.

New York, Sands

Retained on Sieve					Grain fineness number	Water (per cent)	Permea-bility	Bond strength	Compres-sive strength (lbs. sq in.)
200	270	Pan	Clay	Total					
4.94	21.84	47.68	21.12	100.74	239	4.0	3.15	182	
						6.0	5.43	203	
						8.0	5.8	200	
						9.6	10.7		
						11.5	7.5		
12.68	31.52	33.00	13.08	100.16	216	4.0	3.5	171	
						6.0	6.5	186	
						8.0	8.8	181	
						9.7	10.0		
						11.7	13.0		
						13.6	8.2		
18.2	12.8	45.6	12.6	100.2	225	5.0	9.6		9.7
						5.9	10.7		9.3
						7.7	11.5		6.6
12.42	23.64	34.08	12.76	99.60	207	3.9	7.5	142	
						6.1	10.1	181	
						8.6	11.7	172	
						9.6	10.7		
18.60	19.54	22.68	19.34	100.02	186	4.4	7.9	too dry	
						6.0	10.0	175	
						8.3	13.4	163	
						12.1	10.0		
13.99	22.96	38.02	10.9	100.3	217	4.2	7.9		6.8
						6.1	10.2		5.7
						10.2	11.4		5.1
14.64	19.04	22.04	9.70	99.92	175	4.3		Too dry	
						6.0	14.7	178	
						8.0	20.0	161	
						10.0	15.7		
19.46	16.16	14.10	10.24	99.72	153	4.3	14.7	140	
						6.0	21.0	173	
						8.3	22.7	149	
						9.9	20.0		
22.2	11.2	17.0	9.0	100.4	152	3.8	19.8		9.4
						5.5	26.0		6.3
						7.4	27.9		4.4

Footnote to Table 4, pp. 12-13.

Source:

A—Littlefield, M. S., Natural bonded molding sand resources of Illinois: Illinois State Geol. Survey Bull. 50, p. 172, 1925.

B—Logan, W. N., The foundry sands of Indiana: Dept. of Conservation, State of Indiana, Div. of Geol., Pub. No. 92, p. 10, 1930.

C—Sample from an Evansville, Ind., company, tested in present investigation.

D—Crane, P. W., Molding sand work at the University of Cincinnati: American Foundrymen's Assn. Trans. vol. 33, 829-842, 1926.

E—Freeman, C. H., Natural bonded moulding sands of Canada: Canada Dept. Mines, Mines Branch, No. 767, p. 132, 1936.

Table 4.—Tests of Southern

Sample number	Locality	Source[1]	Sieve Analysis, Per Cent							
			12	20	30	40	50	70	100	140
25	Bauman, Ind.	A						.06	.04	0.2
30	Bauman, Ind.	A	.02	.02		.04		.4	.7	1.3
2A	Rockport, Ind.	B							.2	.2
5A	Rockport, Ind.	B						3.0	7.4	11.0
24	Troy, Ind.	B				.1		.2	.2	.2
81	Jeffersonville, Ind.	B				.06		.12	.18	.57
FS	Evansville, Ind.	C				Tr	.2	.4	2.0	2.6
34	Newport, Ky.	A	.06			.04		.07	2.2	2.8
91	Conneaut, Ohio	A				.04		1.2	2.6	4.4
1-J	Delhi, Ohio	D				.08		.16	.38	1.60
47	Canal Fulton, Ohio	D				.08		.22	.62	2.0
53	Galliopolis, Ohio	D				.04		.20	.32	.66
U	Windsor Locks, Conn.	E	.30	.38	.44	.54	.94	1.32	1.62	2.76
T	France	E		.08	.04	.06	.20	.42	1.77	5.62

[1]Footnote on p. 11.

Indiana and Similar Sands

Retained on Sieve					Grain fineness number	Water (per cent)	Permeability	Bond strength	Compressive strength (lbs. sq. in.)
200	270	Pan	Clay	Total					
.04	.04	72.8	24.8	97.8	300	6	2.0	240.9	
						8	2.2	263.7	
						10	2.8	247.6	
5.5	4.9	70.2	15.2	98.28	274	4	2.8	165.3	
						6	3.7	202.2	
						8	4.2	207.6	
5.0	3.0	72.0	19.6	100.0	277	4.3	1.33	193	
						7.0	1.67	197	
						8.6	2.08	270	
						10.4	1.60	244	
4.2	3.7	65.1	5.6	100.0	240	4.0	3.58	135	
						5.7	4.16	152	
						6.6	4.85	159	
						7.7	5.22	173	
						10.2	4.18	176	
.3	.4	72.4	26.2	100.0	297	5.9	2.6	277	
						7.2	5.7	307	
						7.7	2.8	290	
						9.1	2.4	274	
1.97	4.96	84.30	7.84	100.0	289	4.4	5.06	134	
						5.9	5.76	143	
						7.1	5.65	156	
						8.0	5.50	159	
4.6	4.8	69.0	16.6	100.0	272	4.2	3.7		12.3
						5.6	4.9		11.4
						7.4	5.7		9.4
7.0	5.9	59.0	21.3	98.7	262	4	3.3	188.4	
						6	4.0	204.0	
						8	4.5	233.8	
11.1	6.4	60.8	13.0	99.54	251	6	7.7	254.2	
						8	7.3	228.1	
2.70	2.68	63.16	29.24	100.00	283	5.5	2.5		
						7.2	3.2	242	
						8.5	4.0	245	
						11.8	5.2	224	
						12.9	4.7	222	
5.0	4.56	76.4	11.12	100.00	279	5.8	4.6	150	
						6.8		155	
						8.2	4.7		
						9.2	4.9	158	
						10.6	4.5	171	
1.20	1.16	81.98	14.44	100.00	293	4.7	2.4	141	
						5.8	2.7	153	
						7.65	2.8	160	
						9.4	2.7	173	
						11.9	2.6	167	
4.24	7.58	64.38	15.4	99.9	260	4.1	2.0		6.4
						6.0	2.5		6.8
						8.1	2.7		7.0
8.80	13.88	61.98	7.3	100.2	252	4.1	8.6		3.5
						6.0	9.4		3.8
						8.1	8.8		4.0

and much less pan material. The sand is fairly evenly distributed between the pan, 270-, 200-, and 140-mesh sieves and usually also the 100-mesh sieve. The total amount coarser than 70 mesh is usually less than 10 per cent. The permeability ranges from 10 to 24, averaging 19, and the maximum cohesiveness ranges from 139 to 206 at from 5.8 to 13.1 per cent water. The sample of Albany No. 1 sand submitted to us has a grain fineness number of 152 and differs from the grade as defined by Nevin only in being 5 per cent lower in grains retained on the 270-mesh sieve. It has a permeability of 27.3, and a green compressive strength of 6.3 pounds per square inch at 5.5 per cent water. Tests of Albany No. 1 grade sands are given in table 3.

Southern Indiana Sand

A molding sand finer in grain size than the Albany sand is produced in southern Indiana. This sand consists principally of grains passing a 270-mesh sieve (pan material) and has a grain fineness number between 250 and 300. No general name has been applied to molding sands of this grain size although producing companies have their own trade names. For convenience, therefore, these sands are referred to in this report as the Southern Indiana sands, although other grades of sand are also produced in that area. Sands of this grain size are also produced in northern Kentucky and central and northern Ohio, and some of them also enter the Chicago market. The following descriptions apply to the southern Indiana deposits unless otherwise noted.

Distribution.—The Southern Indiana sands are produced chiefly in the vicinity of Sandale, west of Rockport, in Spencer County. Similar sands occur in several of the Ohio River counties, especially near Tell City, Evansville, Camelton, and Jeffersonville. The deposits are principally in ridges and hills on terraces.

Origin.—The Southern Indiana sands probably are wind-blown in origin, that is, they were carried by the wind, like dust, to their present location. Such deposits are called "loess." Some of these sands may be water deposits—materials carried by streams and laid down in the quiet water of lakes. Weathering has leached the carbonates from the upper part of the deposits.

Thickness and overburden.—The deposits usually range from 3 to 10 feet in thickness and have an overburden of 1 to 3 feet of soil and clayey silt. They overlie calcareous silt or sand.

Grain size.—Sands of several grain sizes are found in southern Indiana but much of the sand, and especially that considered here, is largely pan material. Materials of this grain size are more correctly called "silts." However, they are called "sands" in the sand industry and in foundries, and this custom is followed here. The term "silt" is also used in the descriptions of the outcrops where needed to distinguish such materials from the true sands.

Published data on 15 samples from southern Indiana, Kentucky, and Ohio, show that these sands rarely contain as much as 25 per cent of grains coarser than 270-mesh and often less than 5 per cent. They usually contain 60 to 85 per cent pan material and 5 to 30 per cent A.F.A. clay. The remainder is fine sand, nearly all less than 100 mesh in size. Tests of several Southern Indiana and similar sands are given in table 4.

The clay content of some of the southern Indiana deposits is as high as 35 per cent in the upper part but only about 10 per cent near the base. Consequently it is possible to produce material with almost any clay content desired between these limits. Fine- and medium-grained sand low in bond occur in the same area and the very fine grained materials are blended with them in various proportions to supply sand to meet different specifications.

Strength and permeability.—Tests on the 15 samples show these sands to have a maximum bond strength ranging from 145 to 310, and averaging 220. The permeability ranges from 2.8 to 9, averaging 5.1.

CHARACTER OF NORTHERN ILLINOIS SANDS

Distribution

Deposits of fine-grained molding sands which are similar in grain size to the Albany and Southern Indiana sands were found in Henry, Jo Daviess, Mason, Rock Island, and Whiteside counties. Large areas near Chicago which are underlain by sand were examined but no deposits which meet the grain-size requirements were found. One deposit near Chicago is a possible source of fine-grained molding sand although it does not have the same grain-size distribution as the Albany sands.

The most numerous deposits of the Albany type sand were found in Whiteside County, especially in the area south of Morrison. Several promising samples were collected from deposits in Jo Daviess County near Aiken and in Mason County near Mason City.

The only promising deposits of the Southern Indiana type sand were found in the upland areas near the Mississippi River bluffs. Deposits of this sand are present in Rock Island, Whiteside, Carroll, and Jo Daviess counties, but only the area in Whiteside and northern Rock Island counties was sampled in enough detail to show the general character and variations of the deposits.

Origin

Many of the deposits of fine-grained sand in southern Whiteside County are in a large area which was covered by a lake-like expansion of the Mississippi and Rock rivers during Glacial times. Most of the sand deposited in this body of water was medium grained but at certain places where the currents were weaker fine-grained sand was deposited. Conditions were probably similar farther north along Mississippi Valley when the deposits were laid down near Aiken and Rice in Jo Daviess County. The sand formerly covered a much larger area than at present, but much of it has been eroded by the streams and rivers. The remaining deposits occur in terraces and dunes at various levels above the bottomlands of the rivers.

In the area south of Morrison and in northern Rock Island County, sand forms many steep-sided, ridge-like hills, usually elongated in an east-west direction. Much of this sand is also medium grained although in some areas, as at Round Grove and northwest of Lyndon, some of it is fine grained. The origin of these hills is uncertain but the sand was probably deposited in a large body of water although locally it has been modified by wind action.

Near Mason City the most promising deposits are low dunes in the upland area east of Illinois Valley. The sand probably has been carried by the wind from sand deposits in the terraces along Illinois Valley.

The most promising deposits of the Southern Indiana type of sands are all in the loess deposits near Mississippi Valley. The deposits were formed during the Glacial period. At that time the Mississippi River was laden with sediments from the melting glaciers and when the water was high fine-grained materials were deposited widely over the bottomlands. When the water was low the deposits dried out and the fine-grained dust-like materials were easily picked up by the winds and carried onto the uplands.

Sand deposited by glacial waters, or picked up by the wind from glacial deposits and redeposited, usually contains a large amount of carbonates derived from the fine grinding of blocks of limestone and dolomite during the movement of the glacial ice. Such sand as originally deposited is of little value for most foundry uses because the carbonates reduce its refractoriness and give it other undesirable properties. The glacial sands of Illinois, however, have had the carbonates leached from the upper part of the deposits by rain water percolating downward through the sand. The solutions have also carried clay from the surface soil zone and have deposited it in the upper part of the zone from which the carbonates have been leached. Usually the amount of clay ranges from its greatest concentration near the top of the noncalcareous zone to its lowest amount at the base of the zone. The lower part of the noncalcareous zone usually contains little if any more clay than the calcareous, unweathered material below. The transition zone from the noncalcareous to the strongly calcareous material below is thin in deposits like loess, usually about 1 inch, but in the coarser grained deposits it may grade through a zone of a foot or more.

The zone from which the carbonates have been leached and in which a clay bond has been deposited is of workable thickness at many places. As this zone always occurs immediately below the surface, only the top soil has to be removed as overburden before excavating the molding sand.

Mineral Composition

The grains in the Illinois sands are mostly quartz with smaller amounts of several other minerals, particularly feldspar. Many grains have a thin coating of limonite which gives them a light yellow color. The quartz grains are angular and subangular in shape. The Illinois sands are not distinguishable from the Albany sands in shapes of grains. The sands differ in some of the minor minerals but these minerals are not abundant enough to affect the uses of the sand.

The material separated as the clay grade in the standard method of analysis of the American Foundrymen's Association includes all the grains of diameter smaller than about 20 microns. This material is a mixture of quartz, clay minerals, limonite, and organic substances. Quartz and clay minerals vary considerably in relative abundance. The clay minerals occur almost entirely in grains less than 2 microns in diameter. In some sands, however, the clay particles are abundant in aggregates between 2 and 20 microns in diameter. Some quartz is present in the minus 2-micron material and the grains between 2 and 20 microns are predominately quartz.

The bonding substances in the sands consist of clay minerals, limonite, and organic substances. Organic substances are minor and limonite is not abundant. The percentages of iron oxide in three Illinois sands, in an Albany sand, and in a Southern Indiana sand are similar (table 5).

Table 5.—Amount of Ferric Oxide in Molding Sands[1]

Sample number	Fe_2O_3 (per cent)
Albany No. 00	2.26
Evansville	3.23
25	1.65
36	2.72
39	2.64

[1]Analyses by Geochemical Section, Illinois State Geological Survey under the supervision of Dr. O. W. Rees.

Because the clay minerals are the most important bonding substances in the sand, an attempt was made to determine what clay minerals were present in order to compare the Illinois sands with the Albany and Southern Indiana sands. Some of the material less than 2 microns in diameter was separated from 16 Illinois sands, two Albany sands, and one Southern Indiana sand. Limonite was removed by solution in dilute hydrochloric acid. The indices of refraction of aggregates of the grains were determined by immersion in liquids of known indices of refraction. Most of the clays from the Illinois sands had similar indices with their lowest index about 1.525 and their highest index about 1.545. A few had indices as high as 1.550 and one had an index as low as 1.515. The clays from the Albany and Southern Indiana sands had indices from 1.545 to 1.565. Thus the highest index of the Illinois clays was about equal to the lowest of the Albany and Southern Indiana clays.

X-ray identifications of the clay minerals were made on clays separated from a typical Illinois sand (sample 25), a Southern Indiana sand, and an Albany sand. All three were largely illite. The Albany clay also contained a small amount of montmorillonite, a little kaolinite, and some quartz. The Southern Indiana clay, in addition to illite, contained kaolinite and quartz, although less than the Albany clay. The Illinois clay contained about as much kaolinite and quartz as the Southern Indiana clay and a little montmorillonite although less than the Albany clay. In mineral content, the clays differ chiefly in the relative abundance of the minor constituents although no montmorillonite was found in the Southern Indiana clay.

The difference between the indices of refraction of the clays from the Illinois sands and the clays from the other sands apparently is not due to the influence of the minor constituents of the clay minerals or to variation in the amounts of quartz. Although the interpretation is somewhat uncertain, the most probable explanation is that the sands contain different forms of illite. The Albany clay contains illite with relatively high indices of refraction, although the presence of montmorillonite, kaolinite, and quartz, which have relatively low indices, gives the aggregates average indices below those of purified illite. According to this explanation the illite in the Illinois clays has much lower indices than the illite in the Albany clay, as the indices of the aggregates are below those of its other constituents, kaolinite and quartz. Although the Illinois clays contained a little montmorillonite, the amount was too small to influence appreciably the indices of refraction.

Grain size

The samples of Illinois sand represent almost all degrees of coarseness through the range investigated. The grain fineness numbers of 42 samples are between 150 and 250, the interval of the Albany sands of grades 00, 0, and 1, and those of 37 samples are between 250 and 300, the interval of the Southern Indiana sands (table 6).

Many of these samples do not meet other requirements of the Albany and Southern Indiana sands. A common defect is the presence of too much A.F.A. clay. Also the gradation of grain size may differ radically in two sands even though they have the same grain fineness number. Consequently it is important, in attempting to duplicate the Albany and Southern Indiana sands, that a sand have about the same gradation in grain size, that is, about the same amounts of each sieve size.

It is uncertain how closely a sand should coincide with the Albany limits for each sieve size in Nevin's classification (see p. 8). The common variations in the grain size of the sand in the Albany deposits, and consequently the variation in the sand shipped from time to time, indicates that quite a range in percentages on one or more sieves is possible. Furthermore, many published analyses of Albany sand do not coincide exactly with the size limits of Nevin's classification. There seems to be no evidence that the gradation of the Albany sand is the only suitable gradation, or even the best gradation for any particular use. For these reasons, sands that differ slightly in the amount of grains retained on one or two sieves are still considered as of possible use. Even sand that is quite short on one sieve size is still considered to have possibilities if amounts of adjacent sieve sizes counterbalance the deficiency . Excessive amounts on the coarsest or finest grained sizes are more important because an excess of fine particles will reduce the permeability whereas an excess of coarse grains will affect the finish of the castings.

Most of the Illinois sands do not exactly coincide with the grain size of the Albany sand as defined in Nevin's classification although some of them are very close. The Illinois sands commonly have a lower content of grains retained on the 270-mesh sieve than the Albany sands.

Some of the Illinois sands appear to have a grain size almost identical with the Southern Indiana sands. However, since 60 to 75 per cent of the sand consists of pan material that is not further subdivided in the standard sieve analysis, there may be size variations within the pan material that might affect the properties of the sand.

Permeability

The Illinois sands have permeabilities approximately the same as the corresponding grades of the Albany and Southern Indiana sands (table 9).

Strength

Many of the sands tested have a green compressive strength higher than that of the Albany and Southern Indiana sands, although the grain size and A.F.A. clay content are about the same. Exact comparisons between A.F.A. clay content and strength are not to be expected because the amount of A.F.A. clay is not necessarily proportional to the amount of clay mineral which gives the sand its strength. It is probable, however, that the differences in the strength of the sands are probably due to the difference in the character of the illite, the chief clay constituent. The structure of the mineral illite is such that with changes in its composition which would lower its indices of refraction, it approaches the structure of the mineral montmorillonite.[5] Its properties might therefore be expected to approach those of montmorillonite. Montmorillonite is the chief constituent of bentonite clays which are used extensively as bond clays and which have greater bonding power than kaolinite or illite clays. It would be expected, therefore, that the clays in the Illinois sands might have a somewhat higher bonding power than the clays in the Albany and Southern Indiana sands. Consequently Illinois sands can probably be used with a slightly lower A.F.A. clay content than would be acceptable in the Albany or Southern Indiana sands. For sands of the same green com-

[5]Grim, R. E., personal communication.

Table 6.—Samples of Northern Illinois Sands Listed by Fineness Numbers[1]

Grain fineness number	A.F.A. clay (per cent)	Sample number
Grain Class No. 5		
61	4.6	70
67	1.0	110
Grain Class No. 4		
71	3.0	103
74	2.8	54
76	7.4	100
77	7.0	102
78	.5	109
79	6.0	104
80	2.6	95C
88	4.6	94B
90	2.4	64
90	4.0	95B
91	12.0	107
93	7.2	94A
94	9.8	8
96	8.8	55C
97	11.4	50
97	6.2	92C
98	7.2	106
99	4.2	6A
99	17.4	9
99	2.2	63B
Grain Class No. 3		
100	6.8	47
102	16.0	11
102	4.8	58A
103	7.0	60
103	9.8	61
104	5.0	63
104	29.8	99
105	8.0	10
105	6.6	63A
106	2.6	58B
106	8.2	59
106	12.2	95A
107	5.8	6
109	21.4	3D
110	14.0	12
110	19.8	56
113	8.8	98
115	24.4	14
116	29.6	18
116	28.4	55A
117	10.8	45
119	13.0	5
Grain Class No. 3—(con't)		
120	25.2	3AB
120	26.9	55B
120	30.4	57
130	3.4	68B
131	28.4	91
132	9.4	69B
133	22.2	97A
135	14.0	105
137	39.0	3C
138	10.8	78A
Grain Class No. 2		
140	32.6	4
140	8.6	72
141	25.0	97B
148	15.6	28A
152	37.2	92A
155	2.4	25B
155	24.0	52
155	11.6	84A
157	34.0	7
157	7.4	28C
159	7.6	73C
159	5.4	84B
161	18.8	29
163	23.8	96A
166	16.2	73A
169	14.6	51
170	19.0	39A
173	8.2	39B
177	29.2	41
179	15.0	28B
182	14.8	78B
182	31.8	93A
183	36.6	1
187	15.0	65A
189	12.0	96B
190	71.4	62
192	6.0	25
192	17.8	65AB
197	28.2	2
198	50.2	92B
Grain Class No. 1		
200	2.6	32
200	34.8	90
205	30.2	27
211	12.0	25A
Grain Class No. 1—(con't)		
215	38.0	49
215	19.0	65B
219	21.0	67A
222	22.2	38
222	36.2	48
223	37.8	22
224	24.4	82
226	18.4	30
228	23.4	75
229	20.0	73B
230	38.4	93B
234	35.8	69A
255	59.4	101
256	18.8	81B
260	32.4	31
261	26.6	37
266	26.0	74
269	32.2	86A
271	15.8	87
273	23.4	88B
275	37.2	68A
276	51.2	20
278	27.0	77B
278	30.4	81A
279	34.6	43
280	34.2	65C
281	21.8	34
282	39.6	33
282	38.2	67B
286	28.6	35
288	20.0	36A
289	23.2	36
289	28.4	86B
290	29.8	40
290	39.4	83
291	30.4	44
291	34.2	77A
291	26.6	80B
291	15.6	108
292	41.2	66
292	26.8	80A
293	44.4	26
293	12.2	36B
293	26.0	42
294	37.6	79
294	45.0	85
295	43.8	71
295	34.8	88A
297	46.8	89

[1]The grain fineness numbers are classified by the A.F.A. into grain classes as follows:

Grain class	Grain Fineness Nos.
No. 1	200 to and including 300
No. 2	140 to but not including 200
No. 3	100 to but not including 140
No. 4	70 to but not including 100
No. 5	50 to but not including 70

pressive strength and grain size, the Illinois sands might have a slightly greater permeability.

Durability

Tests to determine the durability or life of molding sands have not been standardized and it was not possible to determine this important characteristic of the sands examined. Use of the sands under foundry conditions will probably be necessary to determine whether or not the Illinois sands are as durable as the Albany and Southern Indiana sands.

The durability of molding sands depends largely on the ability of the bonding materials to retain their bonding power after heating. The bond of the sands studied is chiefly clay with small amounts of limonite and organic matter. Organic matter is a nondurable bond since it is readily burned out of the sand. Most of the Illinois sands tested contain little organic bond. Limonite is present in all the samples in small amounts. When heated to over 180° C.[6] limonite loses its ability to rehydrate and thus loses its bonding power. Highly limonitic sands were avoided in sampling, and determinations of the amount of ferric oxide in several samples show that the limonite content of the Illinois sands is comparable to that of the Albany and Southern Indiana sands (table 5). The clay minerals also are permanently dehydrated and thus lose their bonding power when heated above a certain temperature. This temperature is different for the different clay minerals but is probably over 450° C. for all clay minerals. However, the clay minerals in the sands studied are so nearly alike that no great difference in durability is to be expected.

A preliminary investigation indicated there is little difference in refractoriness between the Albany and Illinois sands of similar grain size.

Uniformity

A characteristic of the Albany sand which has favored its use is that its physical properties change very little with small variations in water content so that careful control of temper is not essential. The tests show that some of the Illinois sands are probably equal to the Albany sand in this respect while others are not. In recent years many foundries have adopted testing methods which permit close control of the properties of the sands, and this may make it possible to use sands formerly thought to be unsatisfactory. Where sand control methods are used, it is said: "The use of cheaper local sands is a possibility for considerable savings. The use of such sands might be risky if their condition were not known at all times, but when properly handled, they are superior to a more expensive sand without control."[7]

BLENDING AND PROCESSING

Although some of the Illinois sands described are probably suitable in their natural condition for the uses of the Albany and Southern Indiana sands, many of them could be improved by blending with other sands or by processing. A common fault of some Illinois sand is excessive strength. This could be corrected by blending such sand with a low-clay sand. Some sands which are weakly bonded could be improved and their uses extended by the addition of clay. For specialized uses requiring an accurately controlled sand which would command a premium price, some processing such as washing, screening, crushing, or perhaps air classification might be feasible.

Blending of sands has several advantages. Specifications for sand with certain physical properties can be met by controlling the grain size and amount of clay. The product can also be held more uniform than the natural run of many pits. With a blending plant an operator could supply sand suitable for many more uses than could otherwise be met from one or two deposits.

The most abundant fine-grained sands were found in Whiteside County, and as coarser grained sands are also available a blending plant might well be located in that area. A considerable quantity of foundry sand is used in the Moline-Rock Island area not far away.

To supply the Chicago district a plant located near Chicago would have certain advantages because that area contains much sand which might be used in some blends and would thus cut down the amount of sand to be transported.

[6] Posnjak, E., and Merwin, H. E., The hydrated ferric oxides: Am. Jour. Sci. 4th Series, vol. 47, pp. 311-348, 1919.

[7] Eggleston, G. K., Fundamental considerations in non-ferrous sand control: Am. Foundrymen's Assn. Trans., vol. 8, no. 4, p. 121, 1937.

The possibility of improving some of the sands by blending is discussed under the description of the deposits. The sand from Lansing, south of Chicago, is unlike the Albany sand in certain respects, but because of its favorable location, attempts were made to alter it by blending with other sands (p. 33). Similar combinations are possible with many other sands, but as emphasis was placed primarily on finding natural deposits like the sands now used, methods of improving the other sands were not studied. Many of the sands which did not have a grain size similar to that of the Albany and Southern Indiana sands (table 13) might be used in producing blended sands.

Some molding sands which contain an excess of larger grains might be improved by crushing. A sand with a grain fineness number of 58 was run through a laboratory roll crusher set to crush the grains over 70-mesh and the sand was reduced to a grain fineness number of 136. A considerable variation in grain size is possible by controlling the spacing of the rolls and the rate of feed. It is also possible to produce synthetic sands similar in grain size to the Albany No. 1 and finer sized grades by crushing medium-grained sands and adding bond clay. It is probable, however, that some screening would be necessary since an excess of pan material may be produced in crushing. The Ottawa silica sand and dunes in the Chicago area and elsewhere in northern Illinois are possible sources of medium-grained sand for this use.

USES OF FINE-GRAINED MOLDING SANDS

Fine-grained molding sands are used principally as molds in the manufacture of brass, bronze, aluminum, and light-weight gray-iron and malleable castings, and as facings for heavier castings. Many of the stronger fine-grained sands are used for addition to heaps where renewal of bond is needed. Nevin[8] summarizes the uses of Albany sands as follows:

"Albany No. 00—Low permeability and used only for the smallest castings where a smooth finish is essential.

"Albany No. 0—Small brass, aluminum, and gray-iron castings, an admirable stove plate sand.

"Albany No. 1—For the average castings of from 5 to 75 pounds."

Dietert and Woodliff[9] studied samples of sand from 13 nonferrous foundries and part of their data is summarized in table 8. Tests on samples which show the range of sand used for brass and aluminum castings are given in table 7.

It has been stated[10] that a good molding sand for aluminum alloys will generally meet the following specifications:

Compressive strength (lbs. per sq. in.)	5–9
Permeability	4–8
Clay content (per cent)	20–35
Grain fineness number	175–250

Coarser sand with less clay can be used.

[8]Nevin, C. M., op. cit., p. 69.

[9]Dietert, H. W., and Woodliff, E., Study of nonferrous molding sands: Am. Foundrymen's Assn. Trans., vol. 8, pp. 83–96, 1937.

[10]Recommended practice for sand cast aluminum alloys, Rept. of Nonferrous Div., Committee on Recommended Practice, Am. Foundrymen's Assn. Trans., vol. 6, no. 6, p. 2, 1935.

TABLE 7.—TESTS OF SANDS USED FOR

Sample number	Metal	Weight of castings	Sieve Analysis, Per					
			12	20	30	40	50	70
4	Aluminum and bronze	¼–10 lbs.		0.1	0.1	0.4	0.6	1.2
2	Aluminum	5–100 lbs.		0.1	0.2	1.1	3.6	6.8
5	Aluminum and brass	5–200 lbs.		0.5	0.7	1.7	4.1	13.4
11	Brass	1 oz.–300 lbs		0.5	0.4	0.6	2.7	9.8
9	Brass	10–75 lbs.	0.3	0.5	0.4	1.3	4.2	10.7
14	Brass	45–200 lbs.			0.4	0.2	6.3	1.5
15	Bronze	1–500 lbs.	0.9	3.0	2.6	4.8	6.7	9.5

[1]Dietert, H. W., and Woodliff, E., Study of non-ferrous molding sands: Am. Foundrymen's Assn. Trans. vol. 8, pp. 83–96, 1937.

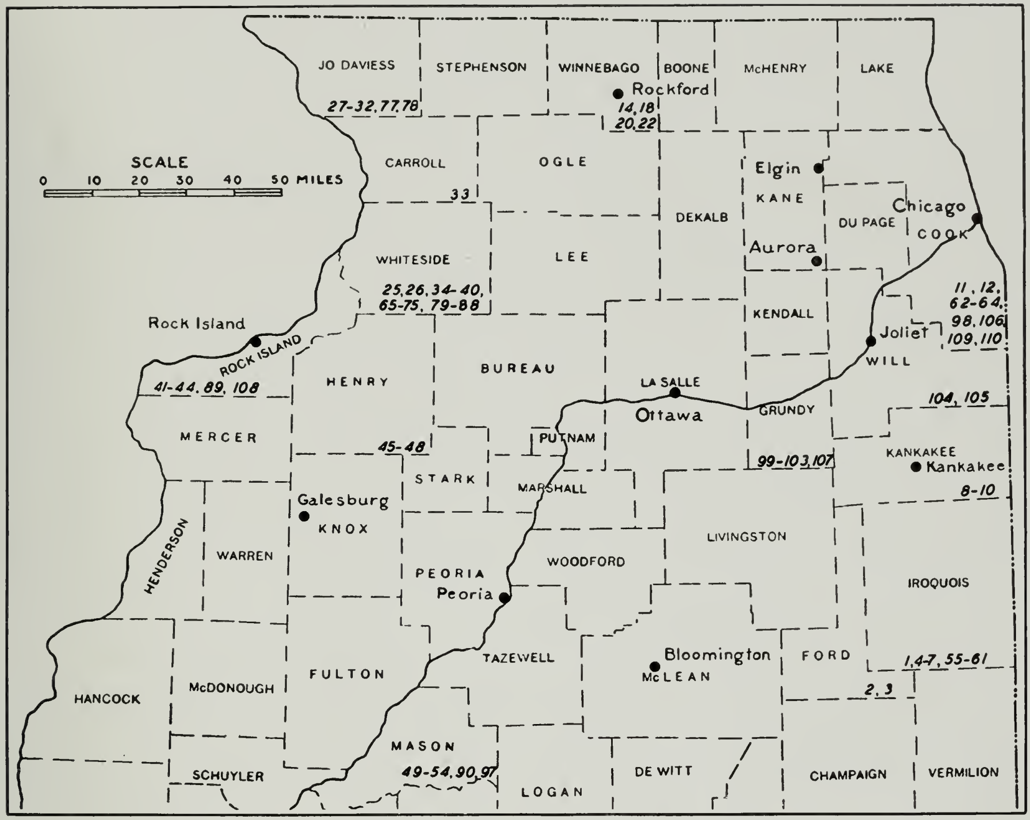

Fig. 1.—Distribution of samples by counties.

Aluminum, Brass and Bronze Castings[1]

Cent Retained on Sieve						Grain fineness number	Water (per cent)	Green permeability	Green compressive strength lb. sq. in.
100	140	200	270	Pan	Clay				
1.1	3.8	5.5	9.1	53.2	24.9	254.0	6.4	3.0	8.8
3.6	5.2	7.0	8.8	42.5	21.1	212.5	8.3	3.0	8.7
8.9	11.8	13.5	11.7	22.9	10.2	154.5	8.0	13.0	5.2
8.6	11.6	11.2	11.7	29.9	13.0	175.7	6.3	12.0	7.9
8.6	14.3	14.0	11.1	22.3	12.3	155.8	6.0	14.5	7.7
31.2	9.5	9.0	9.6	17.6	12.9	137.5	7.2	19.0	6.2
5.8	7.3	8.4	10.0	26.7	14.3	155.2	7.2	9.0	7.7

NORTHERN ILLINOIS DEPOSITS

General Statement

In these preliminary investigations only those deposits were studied where the topography indicated the possibility of large deposits. The descriptions of the individual deposits are based on exposures in road cuts, natural outcrops, and sieve analyses of one or two samples. Many sand deposits show a large range in grain size; from most of them sand could be produced with a little finer or coarser grain size and with a larger or smaller amount of A.F.A. clay than is indicated by the few analyses available. Because of the variability of the deposits it is necessary to prove the presence of a large deposit of suitable sand by digging test pits or drilling auger holes and testing the resulting samples. Before any extensive development is undertaken the sand should be tested thoroughly under foundry conditions.

Promising samples of sand were collected from deposits in Cook, Henry, Jo Daviess, Mason, Rock Island, and Whiteside counties. The tests of the most promising of the Albany type of sands are given in table 9 and of the Southern Indiana type of sands in table 11.

Many other deposits were examined in Bureau, Carroll, Ford, Grundy, Iroquois, Kane, LaSalle, Lee, McHenry, Marshall, Ogle, Peoria, Tazewell, and Will counties but no favorable deposits were found. As a general rule the sands in these counties are coarser grained than the Albany No. 1 sand and the sandy silts contain too much clay to qualify as Southern Indiana type. Many of the deposits examined differed in some important respects from the Albany and Southern Indiana sands and were not sampled. Tests of most of the samples collected in the above counties are given in table 13.

The distribution of the samples by counties is shown in figure 1.

Table 8.—Properties of Sands Used for Aluminum and Brass Castings[1]

Property		Aluminum	Brass
Grain fineness number	Min.	154.5	137.5
	Av.	209.0	156.4
	Max.	254.0	175.7
A. F. A. clay (Per cent)	Min.	10.2	10.2
	Av.	20.2	11.9
	Max.	27.5	14.5
Green permeability	Min.	3.0	12.0
	Av.	5.5	16.3
	Max.	13.0	28.0
Green compressive strength (lbs. sq. in.)	Min.	5.2	3.9
	Av.	7.5	6.4
	Max.	8.9	7.9
Number of samples		6	9

[1]Data from Dietert, H. W., and Woodliff, E., Study of non-ferrous molding sands: Am. Foundrymen's Assn. Trans. vol. 8, pp. 83-96, 1937.

Albany Type Sand

The grain fineness numbers of 42 of the samples collected were between 150 and 250, the range of the Albany Nos. 00, 0, and 1 sands. Of these the samples from 15 deposits had a grain size distribution similar to the Albany sands, and these deposits are described individually, according to grade, and alphabetically by counties. Many of the other samples were less promising because of a high A.F.A. clay content or a radically different gradation of grain size from the Albany sands. They are discussed briefly by counties or by groups of counties that contain similar deposits.

PROMISING DEPOSITS

Albany Type No. 00 Grade

Deposit near Rice, Jo Daviess County

Sand similar to the Albany No. 00 grade occurs in a terrace deposit along the east side of Mississippi Valley near Rice, about six miles south of Galena in Jo Daviess County (fig. 2). The sand is exposed in a road cut at the base of a hill one mile southeast of Rice, in the NW. ¼ NE. ¼ NE. ¼ sec. 22, T. 27 N., R. 1 E.

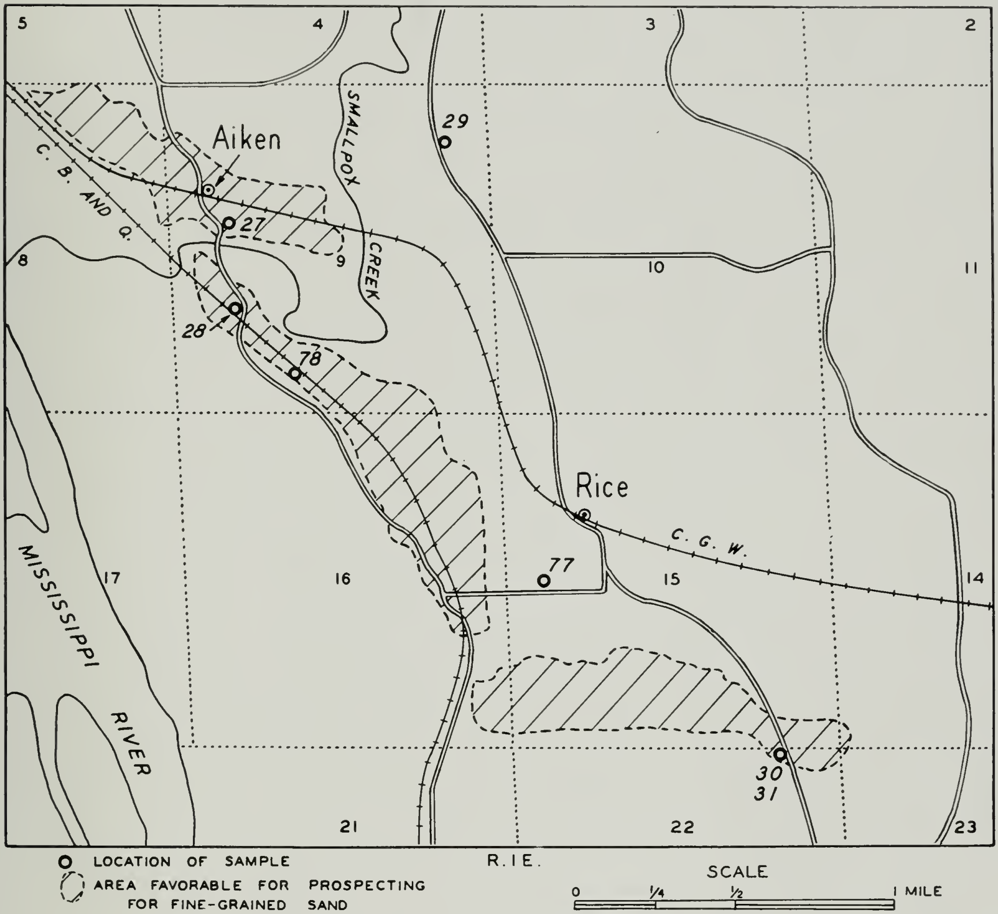

FIG. 2.—Locations of samples collected near Rice and Aiken in Jo Daviess County.

The exposure is as follows:

	Ft.	in.
Soil, dark brown	..	8
Silt, clayey, dark brown, noncalcareous (sample 31)	2	6
Sand, very fine-grained, silty, brownish-gray, noncalcareous (sample 30)	3	
Sand, very fine-grained, silty, light brownish-gray, calcareous, base concealed	10	

The 3 feet of very fine-grained sand represented by sample 30 is similar to the Albany No. 00 grade sand. The results of the tests of sample 30 are given in table 9. The sample differs in grain size from the No. 00 grade in that it contains less sand retained on the 270-mesh sieve and has a slightly higher content of 100- and 140-mesh sand. It might also be classed as a No. 0 sand although the 46 per cent of pan material is more typical of the No. 00 grade. The sample tested contains 18.4 per cent A.F.A. clay, a little below the average of No. 00 grade sands. It has a maximum green permeability of 15.3 at 6.4 per cent water which is high. The permeability of 15.2 at 8.5 per cent water indicates a long range of suitable permeability. The sand has a high green compressive strength of 16.3 pounds per square inch at 6.4 per cent water in spite of the comparatively low clay content for this grade of sand.

The clayey silt (sample 31) overlying the sand might be used as a Southern Indiana type sand although it is higher in clay. Its possibilities are discussed on page 45.

This deposit is in a terrace which extends east and west along the south side of a small valley tributary to Mississippi Valley. It is about a quarter of a mile wide and one mile long, along the south side of section 15 (fig. 2). The top of the terrace is much

Table 9.—Tests of Albany Type Sands from Northern Illinois

Sample number	County	Grade	Sieve Analysis, Per Cent Retained on Sieve: 30	40	50	70	100	140	200	270	Pan	Clay	Total	Grain fineness number	Water (per cent)	Perme-ability	Green compress-sive strength lbs. sq.in.
25	Whiteside	0	Tr	0.4	1.8	2.6	7.4	10.6	17.0	13.4	40.8	6.0	100.0	192	3.5 5.5 6.6 7.6	16.1 16.0 16.0 16.6	9.9 7.5 6.6 5.1
30	Jo Daviess	00		Tr	0.4	1.6	8.0	7.6	11.4	6.6	46.0	18.4	100.0	226	4.5 6.4 8.5	9.7 15.3 15.2	22.5 16.3 13.0
38	Whiteside	0		Tr	Tr	0.2	2.8	8.2	15.8	11.0	39.6	22.2	99.8	222	4.0 5.6 7.5 9.3	2.7 5.8 10.4 15.0	19.0 19.0 14.7 13.2
39A	Whiteside	1		Tr	0.2	2.4	15.2	16.0	15.0	7.2	24.8	19.0	99.8	170	3.8 5.9 8.0 10.3	5.6 16.7 22.4 31.5	22.1 20.2 13.8 11.6
51	Mason	1	Tr	Tr	0.8	3.8	16.4	15.0	14.0	8.6	26.4	14.6	99.6	169	3.9 5.9 7.4 8.6	10.8 18.2 17.6 17.4	15.8 9.8 7.4 7.5
63	Cook	1?	Tr	0.2	0.4	1.4	23.0	54.4	11.2	1.2	3.2	5.0	100.2	104	1.8 2.8 4.0 5.3	52 60 63 61	3.7 2.7 2.3 2.1
63–36	Mixture, Cook and Whiteside	1?		Tr	0.4	1.0	17.8	39.2	9.6	1.6	18.8	11.4	99.8	141	3.5 6.4 8.1	23.5 29.9 27.7	8.6 5.7 4.3

63–38	Mixture, Cook and Whiteside..	1?		Tr	0.2	0.8	11.4	30.6	14.8	5.6	21.6	14.8	99.8	159	3.8 6.2 8.3	13.1 21.3 22.5	15.9 10.1 7.5
63–62	Mixture, Cook...	1?	Tr	0.2	0.4	1.0	19.8	48.4	11.0	1.4	4.6	13.4	100.2	109	3.7 5.1 7.3	42.8 48.2 44.8	11.4 7.6 4.6
65AB	Whiteside.......	0		Tr	Tr	0.6	7.4	15.0	19.4	9.6	30.4	17.8	100.2	192	4.0 5.7 7.4 8.5	5.3 10.0 14.1 20.3	16.6 15.7 13.9 12.2
72	Whiteside.......	1		Tr	0.4	4.8	25.6	21.6	16.8	5.0	17.4	8.6	100.2	140	3.7 6.0 7.9	17.9 24.4 29.5	14.4 9.6 6.5
73A	Whiteside.......	1	Tr	Tr	2.8	8.4	21.2	9.4	7.4	4.2	30.2	16.2	99.8	166	3.9 6.8 8.6	8.8 27.9 26.3	22.5 13.3 11.0
73B	Whiteside.......	00	Tr	Tr	0.6	2.0	6.4	6.2	10.0	6.4	48.2	20.0	99.8	229	3.6 5.6 7.5 9.1	5.7 11.8 10.2 11.2	21.0 14.6 10.4 10.3
96A	Mason..........	1	Tr	0.2	1.2	4.8	15.8	12.6	12.4	6.8	22.2	23.8	99.8	163	3.8 5.6 7.6	2.9 10.6 27.9	21.0 19.5 14.0
98	Cook...........	1?	Tr	0.4	0.4	1.0	14.2	53.0	16.2	1.0	4.6	8.8	99.6	113	2.7 3.7 5.2	39.7 48.9 53.5	5.7 4.0 2.5

dissected by gullies but the flat areas between the gullies have an elevation of 720 to 760 feet, averaging about 140 feet above the Mississippi River bottoms.

The road cut from which the samples were obtained is near the east end of the terrace, and the samples are probably typical of the materials in that part of the terrace. The noncalcareous sand is confined to the weathered zone, and the broader undulations of the surface of the terrace are not likely to affect the presence of suitable sand. The sand deposit is at least 12 feet thick, and any of this sand where weathered probably would give a suitable material. However, thorough prospecting by auger borings or test pits is necessary to determine whether sand similar to that sampled underlies all of the terrace or enough of it to be worked commercially. Similar deposits may also occur along the slopes east and north at about the same elevation.

The terrace is about half a mile south of the Chicago Great Western Railroad siding at Rice.

Deposit at Round Grove, Whiteside County

Fine-grained sand occurs in a long ridge-like hill along the south side of the Chicago and Northwestern Railway at Round Grove, about four miles east of Morrison, in Whiteside County. The sand is exposed in a deep road cut at Round Grove, in shallow road cuts along the north side of the hill east of Round Grove, and in an abandoned molding sand pit west of Round Grove.

On the east side of the deep road cut at Round Grove, in the SE. cor. NE. ¼ NW. ¼ sec. 25, T. 21 N., R. 5 E., the following exposure occurs:

	Ft.	in.
Soil, sandy, brown		6
Sand, fine-grained, slightly clayey, reddish-brown (sample 73A)	3	6
Sand, very fine-grained, clayey, brown, slightly darker than above, noncalcareous (sample 73B)	2	6
Sand and coarse silt interbedded, light brownish-gray, calcareous; in ½- to 2-inch layers, which are mostly horizontal but include some cross-bedded layers; containing a few thin beds of coarse sand; base concealed (sample 73C)	8	

In a road cut along the south side of the secondary road in the SW. ¼ SW. ¼ NW. ¼ sec. 30, T. 21 N., R. 6 E., the following materials are exposed:

	Ft.	in.
Soil, silty, dark gray	1	
Silt, sandy, reddish-brown (sample 74)	3	6
Sand and silt interbedded, like basal unit in outcrop described above, calcareous, base concealed	3	

The section in the abandoned molding sand pit in the SE. ¼ NE. ¼ NW. ¼ sec. 25, T. 21 N., R. 5 E., is slumped, but according to Littlefield[11] 12 feet of calcareous sand was worked.

Of the samples described in the above sections, sample 73B has a grain size closely similar to that of the Albany No. 00 grade sands. Sample 73A is nearest the Albany No. 1 grade and is further described on page 40. Sample 74 is a Southern Indiana type of sand, described on page 43. Sample 73C is similar to Albany No. 1 sand in grain size, but is highly calcareous and therefore not comparable to the Albany sands. Two samples collected by Littlefield (samples 65 and 66, table 12, p. 46), one representing the upper 8 feet and the other the lower 4 feet of sand exposed in the molding sand pit, were both similar in grain size to sample 73C and also were calcareous.

Results of tests on sample 73B are given in table 9. The sand differs in grain size from the Albany No. 00 grade in containing less sand on the 270-mesh sieve and a little more sand on the 100-mesh sieve. Its permeability is 11.8 at 5.6 per cent water, and 11.2 at 9.1 per cent water. This is a little higher than the average for the No. 00 grade sands and is a good range of uniformity. Its green compressive strength is high, 14.6 at 5.6 per cent water and 10.3 at 9.1 per cent water.

The sand is also similar in grain size to many of the finer grained Albany No. 0 grade sands but because of its relatively high percentage of pan material, it is more typical of the No. 00 grade sands. Its permeability is high enough for it to be considered a No. 0 grade sand although it is a little lower than the average for that grade.

[11]Littlefield, op. cit., p. 144.

The outcrops are in a ridge about 1¼ miles long and about an eighth of a mile wide. The crest of the ridge is 30 to 40 feet above the adjacent areas. The greater part of the sand is calcareous and only the weathered zone, 4 to 6 feet thick, contains noncalcareous sands. The weathered zone is somewhat thicker along the crest of the hill than lower along the sides.

In the road cut at Round Grove the Albany type No. 00 grade sand (sample 73B) is overlain by 3½ feet of sand similar to the Albany No. 1 grade. As the lower sand is only about 2½ feet thick it probably could not be worked unless the No. 1 grade sand were also used. The amount of No. 00 grade sand available is not evident from the outcrops, and it will be necessary to make auger borings or test pits along the sand ridge to determine the size of the deposit. The greater part of the deposit appears to be No. 1 grade sand. Road cuts near the east end of the ridge also expose at a lower elevation a calcareous fine-grained sand, probably No. 1 grade, overlain by a very fine grained material, probably loess, which is finer grained than the No. 00 sand and is similar to Southern Indiana sand. The best prospects for finding the No. 00 grade sand are along the higher parts of the ridge. Because the surface of the hill is irregular, the grain size of the material in the weathered zone may be found to vary sharply. This would necessitate careful grading and perhaps production of a large quantity of No. 1 grade sand in proportion to the amount of No. 00 grade sand. These characteristics emphasize the need for careful prospecting in this type of deposit.

Other similar but lower hills south of the hill described may also contain deposits of molding sand. The Soil Survey map of Whiteside County[12] indicates that they are similar to the hill at Round Grove which is described as mixed sand and loess. These hills are in the SE. ¼ sec. 25, NE. ¼ sec. 36, T. 21 N., R. 5 E., SW. ¼ sec. 30, and the NW. ¼ sec. 31, T. 21 N., R. 6 E.

The area is adjacent to the Chicago and Northwestern Railway and is about one mile northwest of the Chicago, Burlington and Quincy Railroad.

[12]Smith, R. S., Ellis, O. I., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Whiteside County soils: Univ. of Illinois. Agr. Exper. Station, Soil Report No. 40, 1928.

Deposit near Denrock, Whiteside County

Fine-grained sand occurs in a large terrace area near Denrock, about two miles west of Lyndon in Whiteside County. It is possible that No. 00 grade sand could be produced although most of the samples from this area are No. 0 grade. The area is discussed in detail under the No. 0 grade sands (p. 30).

Albany Type No. 0 Grade

Deposit at Aiken, Jo Daviess County

Sand similar in grain size to the Albany No. 0 grade sand occurs in a terrace at Aiken, about four miles south of Galena in Jo Daviess County (fig. 2, p. 23). Molding sand was formerly produced from a pit on the south side of the Chicago Great Western Railroad about an eighth of a mile west of Aiken. The sand is exposed in a road cut at the edge of the terrace near Smallpox Creek in the SE. ¼ SW. ¼ NW. ¼ sec. 9, T. 27 N., R. 1 E., as follows:

	Ft.	in.
Soil, brown		8
Sand, very fine-grained, clayey, brown, noncalcareous (sample 27)	2	
Silt, clayey, brown, noncalcareous, base concealed	5	

The sieve analysis of sample 27 (table 13, p. 48) shows the sand to be similar in grain size to the Albany No. 0 grade although a little lower in content of 270-mesh grains. The sample contains 30.2 per cent A.F.A. clay which is a little more than in the Albany sand. The clay content of this sand increases toward the base, so by taking only the upper 1½ feet a material with a lower clay content could be produced. This sand is similar in grain size to that sampled near Rice (p. 22), about two miles southeast, which was classified as a No. 00 grade because of the greater percentage of pan material. Some of the sand in the Aiken terrace may be as fine grained as the Albany No. 00 sand.

According to Littlefield,[13] 3 to 4½ feet of sand was worked in the pit west of Aiken. The upper 3 feet (sample 61, table 12, p. 46) was reported to be finer grained and heavier than the lower 1½ feet (sample 62, table 12). The tests show that the

[13]Littlefield, M. S., op. cit. pp. 117–118.

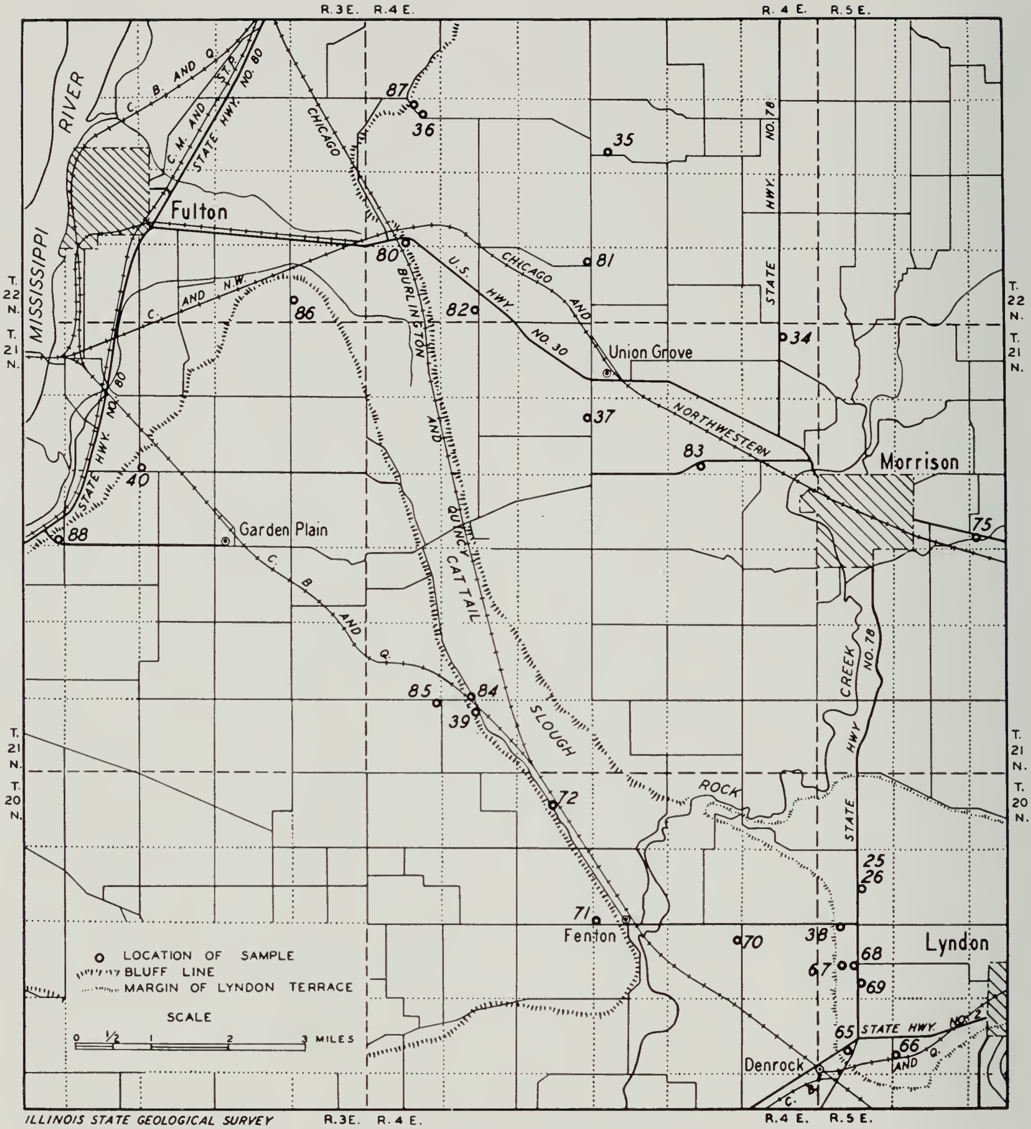

FIG. 3.—Locations of samples collected in western Whiteside County.

upper 3 feet has a grain size similar to that of sample 27. The sand is similar to the Albany No. 0 grade but is a little lower in content of 270-mesh grains and a little higher in content of 200-mesh grains. The sample has a permeability of 12.2 at 6 per cent water which is equal to that of the average Albany No. 0 sand.

The surface of the terrace has an elevation of 640 to 660 feet, about 50 feet above the Mississippi River bottoms. It occurs in the NW. ¼ sec. 9, and NE. ¼ sec. 8, T. 27 N., R. 1 E. but is broken by a short gap about a quarter of a mile west of Aiken. Prospecting by test pits or auger borings is necessary to determine how much of the terrace is underlain by sand.

The terrace is crossed by the Chicago Great Western Railroad.

Deposit near Milan, Rock Island County

Fine-grained sand similar to the Albany No. 0 grade underlies a terrace area about two miles west of Milan. Littlefield[14]

[14]Littlefield, M.S., op. cit. p. 138.

sampled 3½ feet of fine yellow sand in the SW. cor. SW. ¼ SE. ¼ sec. 22, T. 17 N., R. 2 W. The sample (110, table 12, p. 46) in grain size is similar to the Albany No. 0 grade although it is a little higher in content of 70- and 100-mesh grains. It has a very low permeability. Littlefield states, "It is not probable that this deposit contains more than 10,000 tons but the nearness of a market and the adjacent railroad should stimulate prospecting in the vicinity." The area is along the Chicago, Rock Island and Pacific Railroad.

Deposit near Lyndon, Whiteside County

Sand similar to the Albany No. 0 grade sand occurs in a ridge-like hill along the south side of the Langdon school, 2½ miles northeast of Lyndon and about five miles south of Morrison (fig. 3). The sand is exposed in a road cut of State Highway No. 78 at the center of sec. 7, T. 20 N., R. 5 E. The road cut is badly slumped but the following beds were exposed by digging a deep channel in the east face below the crest of the hill:

	Ft.	in.
Soil, brown	1	
Silt, very clayey, brown	1	
Silt, clayey, brown (sample 26)	3	
Sand, very fine-grained, slightly silty and clayey especially in upper part, brownish-gray, noncalcareous (sample 25)	4	
Sand, similar to that above but containing slightly less clay and silt, lower part faintly calcareous (sample 25B)	3	6
Sand, similar to above but highly calcareous, base not reached		6

The lower 2 feet of this section occurs below the level of the highway and was obtained in an auger boring.

Tests on sample 25 (table 9, p. 24) show that in grain size this material is very close to the average of the Albany No. 0 grade. It is a little lower in the amount retained on the 270-mesh sieve and a little higher in the amount retained on the 100-mesh sieve. Its grain fineness number of 192 is typical of the No. 0 grade sands. The sand contains only 6 per cent A.F.A. clay which is a little less than in the Albany sands of this grade. This is probably a desirable characteristic because the bonding strength of the clay appears to be higher in the Illinois sand than in the Albany sand. If a higher clay content is desired, it can easily be obtained by including a little of the overlying clayey silt. A sample (25A, table 13, p. 48) representing 6 inches of the overlying material and the upper 3½ feet of the sand from which sample 25 was taken, contained 12 per cent of A.F.A. clay.

The permeability of sample 25 shows remarkably little change with variation in the moisture content. The sample had a permeability of 16.1 at 3.5 per cent water and 16.6 at 7.6 per cent water. The permeability is higher than the average for the Albany No. 0 grade. The sand has a green compressive strength of 7.5 pounds per square inch at 5.5 per cent water.

Sample 25B represents 3 feet 6 inches of sand, the lower part of which is slightly calcareous. The sieve analysis (table 13) shows it is slightly coarser grained than sample 25 although the difference is principally in the much lower amount of pan material and the lower percentage of clay. It has the grain size of an Albany No. 1 grade sand but would require the addition of some bonding material. The bond could be obtained by adding some of the clayey silt represented by sample 26. If about 25 per cent of sample 26 were mixed with the sand it would contain about 13 per cent clay and could be classified as either a coarse-grained No. 0 grade or a fine-grained No. 1 sand. This sand may contain too much calcium carbonate to be used as an Albany type sand. However, sands containing a greater amount of carbonates have been used, and it is possible that a market for this sand could be found, especially if it could be produced cheaply after removal of the overlying sand.

Sample 26 might be used as a Southern Indiana type sand (p. 45) although its high clay content places it at a disadvantage in comparison with other sands of Southern Indiana type in the same general area. The sieve test of sample 26 is given in table 13.

The hill from which the above samples were collected is about 20 feet high, 200 to 300 feet wide, and nearly half a mile long. Fine-grained sand is exposed in several road cuts in nearby hills. Similar hills occur in sections 7, 8, 17, and 18, T. 20 N., R. 5 E., and it is possible that many of them contain fine-grained sand. Variations in the grain size of the materials composing these hills is to be expected and thorough prospecting is necessary to establish the presence of a large enough quantity of suitable sand to warrant a commercial operation.

The deposit sampled is a little more than two miles north of the Chicago, Burlington and Quincy Railroad.

Deposit near Denrock, Whiteside County

Fine-grained sand is exposed at many places in a large terrace about half a mile northeast of Denrock and two miles west of Lyndon. A large part of the sand in this area appears to be similar to the Albany No. 0 grade. No. 1 grade sand is also present and possibly No. 00 grade sand. The sand is exposed in road cuts and was penetrated in several auger borings. The locations where the samples were collected are shown in figure 3.

In the north part of the area the sand is exposed in the road cut on the south side of the road in the NW. 1/4 NE. 1/4 NW. 1/4 sec. 18, T. 20 N., R. 5 E., as follows:

	Ft.	in.
Soil, brown		6
Sand, very fine-grained, silty, brown, noncalcareous, (sample 38)	2	4
Sand, similar to above but slightly more clayey, noncalcareous	2	
Silt, light brown, calcareous	3	
Sand, coarse, pebbly, calcareous, base concealed	5	

Half a mile south of the above outcrop an auger boring near the edge of the terrace, a quarter of a mile west of State Highway No. 78, in the NW. 1/4 NE. 1/4 SW. 1/4 sec. 18, T. 20 N., R. 5 E., penetrated the following beds:

	Ft.	in.
Soil, brownish-gray		6
Sand, very fine-grained, brown (sample 67A)	1	6
Silt, clayey, sandy, light brown, noncalcareous (sample 67B)	4	3
Silt, more clayey than above, tough, noncalcareous		6
Sand, medium- to coarse-grained, light gray, calcareous, base not reached		3

A quarter of a mile east of the auger boring just described another boring was made along State Highway No. 78 near the NE. cor. SW. 1/4 sec. 18, T. 20 N., R. 5 E., and the following beds were penetrated:

	Ft.	in.
Soil, brownish-gray		6
Silt, sandy, clayey, brown (sample 68A)	5	6
Sand, fine-grained, weakly bonded, light brown, noncalcareous (sample 68B)	4	6
Sand, similar to above but faintly calcareous, base not reached		6

A quarter of a mile south of the auger boring just described the sand is exposed in a shallow road cut along the east side of State Highway No. 78, in the SW. 1/4 NW. 1/4 SE. 1/4 sec. 18, T. 20 N., R. 5 E., as follows:

	Ft.	in.
Soil, sandy, dark brown	1	6
Silt, clayey, sandy, brown (sample 69A)	2	
Sand, fine-grained, light brownish-gray, noncalcareous (sample 69B)	3	
Sand, similar to above but faintly calcareous, base concealed	1	

Nearly a mile farther south fine-grained sand is exposed in a road cut of State Highway No. 2 near the margin of the terrace, in the NE. 1/4 NE. 1/4 SW. 1/4 sec. 19, T. 20 N., R. 5 E. The road cut is badly slumped and the following beds were penetrated in an auger boring on the south side of the road, about 150 feet east of the edge of the terrace:

	Ft.	in.
Soil, black		8
Sand, very fine-grained, light brown, noncalcareous (sample 65A)	2	6
Sand, similar to above but slightly more clayey (sample 65B)	1	10
Silt, clayey, brown, noncalcareous, base not reached (sample 65C)	6	

The silt at the base of this boring overlies a fine-grained sandy gravel.

Sample 65AB represents the interval covered by samples 65A and 65B in the above boring.

About half a mile east of the boring just described an auger boring on the east side of the road, north of the railroad, in the NW. 1/4 SW. 1/4 SW. 1/4 sec. 20, T. 20 N., R. 5 E., penetrated the following beds:

	Ft.	in.
Soil, black		8
Silt, clayey, brown, noncalcareous (sample 66)	4	6
Clay, silty, tough, noncalcareous		4
Silt, sandy, mottled light and dark brown, noncalcareous, base not reached	1	6

Three samples (38, 65AB, and 67A) collected along the margin of the terrace are similar in grain size to the Albany No. 0 grade sand. This sand overlies a sandy clayey silt (samples 65C and 67B) that may be a Southern Indiana type sand (p. 45) although it is higher in clay content than is usual for those sands. Along the western margin of the terrace the silt overlies coarse sand and gravel but farther east along State Highway No. 78 it or a similar silt (samples 68A and 69A) overlies sand (samples 68B and 69B) similar to the Albany No. 1 grade although weakly bonded.

Tests of samples 38 and 65AB are given in table 9 (p. 24) and sieve analyses of the other samples are given in table 13 (p. 48).

Sample 38 has a grain size similar to that of the Albany No. 0 grade although it might also be used as a coarse-grained No. 00 grade sand. Its grain fineness number of 222 classifies it as either a No. 0 or a No. 00 grade sand. It differs from the No. 0 grade only in being a little lower in sand retained on the 270-mesh sieve. Its clay content is close to the upper limit for the grade, and consequently it has a comparatively high compressive strength. Its permeability of 10.4 at 7.5 per cent water is a little below the average of the Albany No. 0 sand but is above the average for the No. 00 grade.

Sample 65AB is also a No. 0 grade sand but is a little coarser grained than Sample 38. It has a little more sand on the 100-mesh sieve and less on the 270-mesh sieve than the Albany No. 0 sand. Its grain fineness number of 192 is typical of the coarser grained No. 0 grade sands. This sample contains a little less clay than sample 38 and consequently it is not quite as strong and has a higher permeability. Its permeability is about equal to the average for the Albany No. 0 grade sands.

Sand with a grain size similar to that described is also exposed in other road cuts in the area and it appears that a large quantity of fine-grained sand is available. The area from which these samples were collected is more than 1½ miles long and at least a quarter of a mile wide. The terrace extends east of State Highway No. 78 as far as Lyndon and fine-grained sand may underlie part of that area. The Denrock area is directly south of the Lyndon area in which fine-grained sand occurs in hills. The two areas may overlap.

Detailed prospecting is necessary to prove that the area can support a commercial operation. However, judging by the outcrops and tests, the area can probably supply large quantities of Nos. 0 and 1 sands, and a smaller amount of No. 00 sand. It may be necessary to add bond clay to the No. 1 grade sand. The grades of sand can be somewhat controlled by varying the depth of sand worked. For example, sample 65AB represents about 4 feet 4 inches of sand which was slightly finer grained in the lower part. The upper 2 feet 6 inches (sample 65A) in grain size is similar to the coarser sands of the Albany No. 0 grade, whereas the lower 1 foot 10 inches (sample 65B) is only slightly coarser grained than some of the Albany No. 00 sands.

The deposits in this area are similar to the Albany deposits which also commonly contain several grades of sand in comparatively small areas. Although this adds to the difficulty in grading, it adds to the number of uses for which sands can be supplied from one pit. If it were desired to produce a coarser sand in order to supply a still wider range of uses, much coarser sands than those described are available nearby. Coarse sand occurs in the flat lowland west of the terrace and sample 70 (table 13, p. 48) represents about 3 feet of sand exposed along the secondary road in the NE. ¼ SE. ¼ NE. ¼ sec. 14, T. 20 N., R. 4 E. The sample is as coarse grained as the Albany No. 3 grade; 85 per cent is coarser than a 100-mesh sieve. The sample contains only 4.6 per cent A.F.A. clay and probably would require the addition of bond clay.

The south end of the area is crossed by the Chicago, Burlington and Quincy Railroad.

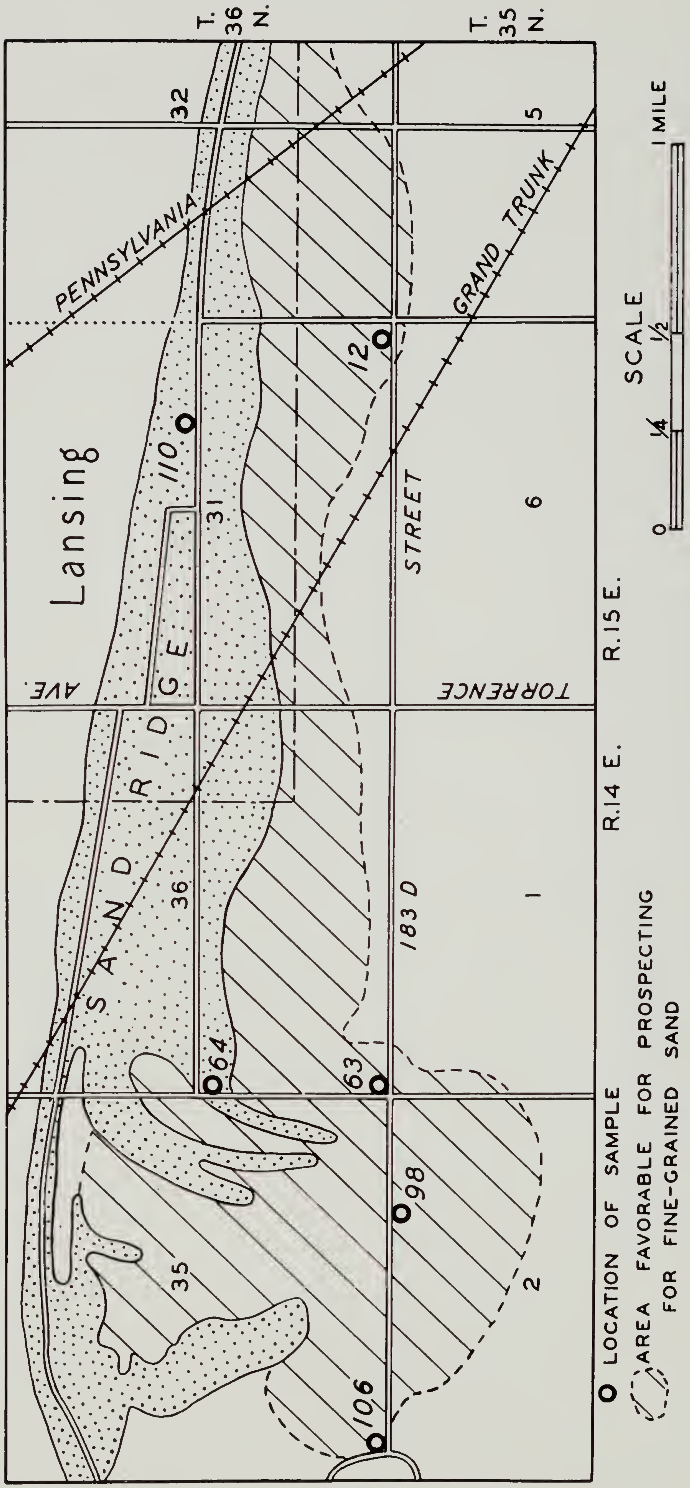

Fig. 4—Locations of samples collected near Lansing in Cook County.

Deposit near Morrison, Whiteside County

Fine-grained sand underlies a terrace area along French Creek, about one mile east of Morrison. The sand is exposed in a cut bank along the creek south of U. S. Highway No. 30, in the NE. ¼ SW. ¼ SW. ¼ sec. 16, T. 21 N., R. 5 E., as follows:

	Ft.	in.
Soil, dark brown		10–12
Sand, very fine-grained, silty, brown, noncalcareous (sample 75)	2	8
Sand, fine-grained, brownish-gray, calcareous, base concealed	10	

Sample 75 (table 13, p. 48) has a grain fineness number of 228 which classifies it as an Albany No. 0 type sand or a coarse-grained No. 00 sand. However, in gradation of the sand it differs in several respects from the Albany sand. It has a little higher percentage of grains on the 65- and 100-mesh sieves and in the pan and a relatively low percentage between the 100- and 270-mesh sieves. The sand is intermediate in character between the Albany and Southern Indiana sands. Its permeability is probably low for an Albany sand and high for a Southern Indiana sand.

The size of this deposit is uncertain and prospecting is necessary to determine whether it is large enough to justify development. The exposure of sand is in a comparatively small remnant of the terrace but other areas at about the same elevation in this general vicinity may contain similar sands.

The area is near the Chicago and Northwestern Railway.

Deposit near Union Grove, Whiteside County

Fine-grained sand is exposed in a road cut about one mile southwest of Union Grove near the NE. cor. SE. ¼ SW. ¼ sec. 32, T. 22 N., R. 4 E., as follows:

	Ft.	in.
Soil, dark brown		9
Sand, fine-grained, silty, dark brownish-gray, noncalcareous (sample 82)	2	9
Sand, medium-grained, noncalcareous, base concealed	1	

Sample 82 (table 13, p. 48) is similar in grain size to the Albany No. 0 grade. It is lower in grains retained on the 270-mesh sieve and a little higher in grains on the 100-mesh sieve. It contains a little more A.F.A. clay than the Albany sands.

The deposit occurs in a low hill on the upland. As road cuts in this general area indicate that the materials are variable in character, careful prospecting is needed to determine the quantity and quality of the sand available.

The area is about one mile south of the Chicago and Northwestern Railway.

Albany Type No. 1 Grade

Deposit at Lansing, Cook County

The finest grained sand found in the Chicago area occurs south of Chicago between Lansing and Thornton. The sand in this area, although differing in several respects from the Albany sand, is most nearly like the Albany No. 1 grade. The sand has several characteristics which may enable it to meet the requirements for some uses where Albany sand is now employed. Its location in the Chicago district is advantageous and would probably justify the cost of processing or blending with other sands if this were necessary to produce a sand that could compete with the Albany sands.

The sand is exposed in ditches along the roads and was penetrated in several auger borings in the area shown in figure 4. The sand is exposed in a ditch at the SW. cor. sec. 36, T. 36 N., R. 14 E., as follows:

	Ft.	in.
Soil, black, very sandy		8–12
Sand, fine-grained, light yellowish-brown at top, reddish-brown at base, noncalcareous (sample 63A)	2	4
Sand, fine-grained, light brownish-gray, noncalcareous; slightly coarser grained and not as well bonded as above (sample 63B)		8
Sand, similar to above but light gray, calcareous, base concealed		4

Sample 63 is a combination of samples 63A and 63B.

The beds exposed in a ditch in the NW. ¼ NW. ¼ NE. ¼ sec. 2, T. 35 N., R. 14 E., are as follows:

	Ft.	in.
Soil, black, sandy		6–8
Sand, fine-grained, mostly reddish-brown; the upper 1 foot a little finer grained than the lower 3 feet; a slightly greater clay content in a zone from 1 to 2 feet below the top (sample 98)	4	4
Sand, fine-grained, gray with black streaks, faintly calcareous, base concealed		6

In an auger boring at the southeast corner of sec. 31, T. 36 N., R. 15 E., the following beds were penetrated:

	Ft.	in.
Soil, brown, sandy		4
Sand, fine-grained, slightly clayey, brown (sample 12)	1	2
Sand, fine-grained, yellow, noncalcareous; contains very little clay; auger hit large pebble at base	2	4

The following beds are exposed in a ditch along the road at the road "T" in the SW. ¼ SW. ¼ SW. ¼ sec. 35, T. 36 N., R. 14 E.:

	Ft.	in.
Soil, dark brown, sandy		6
Sand, fine-grained, yellowish-brown, noncalcareous, base concealed (sample 106)	2	

The sieve analyses, green compression, and permeability tests of samples 63 and 98 are given in table 9 (p. 24), and the sieve analyses of the remaining samples are given in table 13 (p. 48). The sand has a grain-size gradation unlike the Albany grades although nearest to the Albany No. 1 grade. It has a high percentage of grains on the 140-mesh sieve, usually more than 50 per cent, and about 75 per cent of the sand is retained on the 100- and 140-mesh sieves. In this it differs from the Albany No. 1 grade which has the sand well distributed between these sieve sizes and the 200-mesh, 270-mesh and pan material. The percentage of grains coarser than the 70-mesh sieve is lower in this sand than is common in the Albany No. 1 grade although its grain fineness number which ranges from 98 to 113 classifies it as a No. 1½ or a No. 2 grade. The high concentration of the grains on two adjacent sieves gives an open texture and an unusually high permeability. The two samples tested (63 and 98) have permeabilities from 50 to 60 which is average for the Albany No. 2 grade sands. The samples are weakly bonded and would require the addition of clay to give them strength. A sample to which 10 per cent of a local silty clay was added (sample 63-62, table 9) has a permeability of 48 which is high for a No. 1½ grade sand. This sand, therefore, appears to be sufficiently fine grained to give castings the finish of an Albany No. 1 grade sand although open enough to have the venting characteristics of a No. 2 grade sand.

As mentioned, most of this sand appears to be deficient in bond, containing from 5 to 8 per cent A.F.A. clay. One sample (12) contains 14 per cent A.F.A. clay but represents only the upper one foot of the deposit which is usually more strongly bonded than the lower part. A sand with sufficient strength might be produced if only the upper 1 to 2 feet of sand is used. This upper sand is not only better bonded but is slightly finer grained than the lower part of the sand.

The compressive strength of the sand can be increased by adding a small amount of bentonite or fireclay bonding clay. The effect on the properties of the sand by bonding with the clay available near the deposit is shown by tests of sample 63-62 (table 9). This sample is a mixture of 90 per cent of sample 63 described above and 10 per cent of sample 62 (table 13). Sample 62 is principally A.F.A. clay with a small amount of pan material and sand. Use of this material as a bond affects the average grain size of the sand only slightly. Sample 63 has a grain fineness number of 104 and the mixture of the two samples (sample 63-62) has a grain fineness number of 109. The addition of 10 per cent of the local clay gave the sand, at 5.1 per cent water, a green compressive strength of 7.6 pounds per square inch and a permeability of 48.2.

Sample 62 represents 2 feet 6 inches of noncalcareous silty clay directly below the soil and overlying a calcareous silty clay. It was collected from an auger boring about four miles southwest of Lansing, near Chicago Heights, at the SE. cor. NE. ¼ sec. 16, T. 35 N., R. 14 E. Similar material is exposed along North Creek and in ditches along the roads at many places in the area immediately south of the sand deposits. Where overlain by sand the clay has been protected from weathering and is all or nearly all calcareous.

It is possible that this clay could be produced as a bond clay for general use. Because of its favorable location, thin overburden, and ease of mining, it might be produced at relatively low cost. However, more of this clay is required to bond the sand than of the standard bonding clays. Its bonding power would be increased if the sand and silt were removed but this additional processing might make the cost prohibitive. Further tests are needed to determine the effect of this clay on other properties of the sand such as durability. The clay minerals, however, appear to be the same as those in the natural-bonded sands of northern Illinois.

Blending sample 63 with an equal amount of sample 38, a Whiteside County No. 0 grade sand which has a high green compressive strength, gives the results shown in tests of sample 63-38 (table 9). The addition of the fine-grained sand gives the mixture a grain fineness number of 159 which classifies it as a No. 1 grade sand, although it is a little lower in content of grains on the 270-mesh sieve. The mixture, at 8.3 per cent water, has a green compressive strength of 7.5 pounds per square inch, and a permeability of 22.3. The permeability is slightly above the average for a No. 1 grade sand.

When sample 63 is blended with 25 per cent of a Southern Indiana type sand (sample 36) the mixture has the characteristics shown by tests of sample 63-36 (table 9). The mixture has a grain fineness number of 141 and could be classified as a No. 1½ grade sand or possibly as a coarse-grained No. 1 sand. It is lower in 200- and 270-mesh sand and higher in 140-mesh sand than most of the Albany No. 1 grade sands. At 6.4 per cent water the mixture has a green compressive strength of 5.7 pounds per square inch and a permeability of 29.9. Addition of a little more of sample 36 would increase the strength and probably not lower the permeability below that of an average No. 1½ grade sand.

The most favorable part of the Lansing area for prospecting for fine-grained sand is shown in figure 4. The fine-grained sand occurs in the low area along the south side of a sand ridge which extends from the Illinois-Indiana state line through Lansing to Thornton. The extent of the fine-grained sand can be determined only by auger borings or test pits although in the S. ½ sec. 36 the south margin of the area underlain by sand is marked by a distinct southward slope to a lower area which is underlain by clay. This topographic break is close to the position of the 615-foot contour as shown by the topographic map. The north boundary of the area is less distinct, as the fine-grained sand probably grades into the coarser sand of the higher area. It probably coincides generally with the base of the slope of the sand ridge, which is usually at about the position of the 620-foot contour although locally higher than that.

Sand only slightly coarser grained than that described occurs in a narrow ridge which is a southward branch of the main sand ridge (fig. 4). The sand is exposed in a road cut near the NW. cor. SW. ¼ sec. 36, T. 36 N., R. 14 E. About 5 feet of sand overlain by 6 inches of dark gray sandy soil is exposed above the level of the road. The sand is light yellowish brown at the top and lighter colored toward the base. It is noncalcareous and has very little bond. It probably extends 2 to 4 feet below the base of the outcrop to the level of the surrounding lower land but the lower part might be calcareous. A sample of the sand (64) differs from the sand in the area south of the ridge only in having about 10 per cent more sand retained on the 100-mesh sieve and about 10 per cent more on the 140-mesh sieve. It contains only 2.4 per cent A.F.A. clay and would require the addition of bond clay for making molds. It might be used in its natural state as a fine-grained core sand.

This ridge is nearly half a mile long but only about 200 feet wide. Two parallel somewhat longer ridges occur just west of this ridge and may contain similar sand. The sand ridge about half a mile west in the center of the W. ½ sec. 35 may also contain fine-grained sand.

The sand composing the major part of the ridge north of the deposits described is coarser grained than the Albany sands considered in this investigation. Most of this sand contains 75 per cent or more of grains retained on the 100-mesh sieve, and it contains very little bond. Sample 110 (table 13) was collected from a small pit in Lansing. A similar ridge is about two miles south, extending southeast from Glenwood, and another is about three miles north, near Calumet City. Sample 109 (table 13) was collected from the ridge near Calumet City. No fine-grained sand was found along these ridges although a few auger borings were made near them.

Because it is near Chicago the land in which the fine-grained sand occurs may be comparatively high priced. Some of the area is used for truck gardening, but a large part of it, especially that in sec. 35 (fig. 4), is farm land. In digging molding sand it is usually possible to overcast the soil overburden into the mined-out area so that the land can be used for agricultural purposes after the sand has been removed. Such a procedure would be practical in this area because it is relatively high and would not be excavated to water level. At most places the molding sand overlies calcareous sand which would be left and would provide drainage.

Certain parts of the area may not be available for development. At Lansing a small part of the area has been subdivided into lots and the area south of 183d street is a Forest Preserve.

The east part of the area is crossed by the Pennsylvania and Grand Trunk Railroads and the Chicago and Eastern Illinois Railroad is about one mile west of the area.

Deposit near Colona, Henry County

Sand occurs in low dunes on a large terrace south of Colona in the lower part of Green River valley at its junction with Rock River. Some of the sand is similar to the coarser sands of the Albany No. 1 grade although much of the sand is somewhat coarser grained. Where exposed in a road cut along U. S. Highway No. 6 in the SE. 1/4 SE. 1/4 SW. 1/4 sec. 11, T. 17 N., R. 1 E., the sand is as follows:

	Ft.	in.
Soil, dark gray		8
Sand, fine-grained, slightly clayey, brownish-gray, noncalcareous (sample 45)	1	4
Sand, similar to above but contains little clay, base concealed	2	

The sieve analysis of sample 45 (table 13, p. 48) shows that at this particular place the sand is a little too coarse grained to be classified as an Albany No. 1 grade. However, Littlefield[15] collected three samples from the SW. 1/4 sec. 11, T. 17 N., R. 1 E., one of which was coarse grained, one (sample 94) was similar to sample 45, another (sample 95) was similar to the Albany No. 1 grade, although a little lower in content of grains retained on the 270-mesh sieve and of pan material. Tests of samples 94 and 95 are given in table 12 (p. 46).

According to Littlefield the thickness of the workable sand ranges from 1 to 3 feet and the samples represent producible grades. The amount of sand available is probably hundreds of thousands of tons.

The terrace on which these deposits occur has an elevation of 580 to 600 feet and its surface is about 20 feet above Green River. The extent of the terrace areas is shown on the soil map of Henry County.[16] The area is crossed by the Chicago, Burlington, and Quincy Railroad.

Deposit near Aiken, Jo Daviess County

A terrace along the east side of Mississippi valley near Aiken (fig. 2, p. 23) four miles south of Galena, is underlain by sand that is similar in grain size to the Albany No. 1 grade. The sand is exposed in a road cut east of the Chicago, Burlington, and Quincy Railroad in the SE. 1/4 NW. 1/4 SW. 1/4 sec. 9, T. 27 N., R. 1 E., as follows:

	Ft.	in.
Soil, dark brown		8
Sand, fine-grained, reddish-brown, noncalcareous; the lower 1 foot a little more clayey than above (sample 28A)	2	10

An auger boring below this outcrop penetrated the following beds:

	Ft.	in.
Sand, fine-grained, reddish-brown, noncalcareous (sample 28B)	2	6
Sand, very fine-grained, brownish-gray; less clayey than above (sample 28C)	1	6
Sand and silt interbedded, noncalcareous; auger hit boulder or bedrock at base		8

[15] Littlefield, M. S., op. cit., p. 116.

[16] Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Henry County Soils: Univ. Illinois Agri. Exper. Station Soil Report no. 41, 1928.

A little more than a quarter of a mile southeast the sand is poorly exposed in an excavation along the southwest side of the railroad near the center of the SE. ¼ SW. ¼ sec. 9, T. 27 N., R. 1 E. An auger boring near the excavation penetrated the following beds:

	Ft.	in.
Soil, dark brown		6
Sand, fine-grained, dark brown, clayey (sample 78A)	2	9
Sand, very clayey		3
Sand, fine-grained, brownish-gray, more clayey at base (sample 78B)	3	
Silt, sandy, clayey, noncalcareous, base concealed		6

Sieve analyses of the samples referred to above are given in table 13 (p. 48). All of the samples have a grain size very close to that of the Albany No. 1 sands although all are a little lower in content of grains retained on the 270-mesh sieve. In the road cut, the lower 1 foot 6 inches of the sand (sample 28C) is less strongly bonded than the upper 5 feet 4 inches. The uniformity of the sand is shown by the averages of the samples obtained at each locality (table 10).

TABLE 10.—AVERAGE ANALYSES OF SAMPLES FROM TERRACE SOUTH OF AIKEN

Retained on sieve number	Samples 28A, 28B, 28C	Samples 78A, 78B
30	Trace	Trace
40	0.5	0.3
50	2.2	1.8
70	4.1	4.5
100	15.8	17.9
140	17.0	17.7
200	15.9	15.4
270	6.9	3.2
Pan	24.5	26.1
Clay	13.6	12.9
Grain fineness number	162	161

The most promising area in which to prospect for fine-grained sand is in the terrace along the Chicago, Burlington, and Quincy Railroad (fig. 4). The terrace has an elevation of 600 to 620 feet and extends southeast from Smallpox Creek for about 1¼ miles. It is from an eighth to a quarter of a mile wide. The samples tested were collected near the northwest end of the terrace and the character of the deposits farther southeast will have to be determined by test pits or auger borings. Some medium- and coarse-grained sands are exposed at the south end of the terrace and it is possible that the fine-grained sands are not present there or are covered by the coarser sands.

Deposits near Mason City, Mason County

A large area north and west of Mason City is underlain by sand, some of which is similar in grain size to the Albany No. 1 grade. Most of the sand exposed is a little coarser grained than the No. 1 grade. The locations near Mason City where the samples were collected are shown in figure 5.

Sand similar to the No. 1 grade is exposed in a road cut about one mile north of Mason City along State Highway No. 24, about 50 yards south of the NW. cor. sec. 5, T. 20 N., R. 5 W., as follows:

	Ft.	in.
Soil, sandy, black	1	
Sand, fine-grained, dark gray, noncalcareous (sample 52)	2	6
Sand, fine-grained, brown, noncalcareous (sample 51)	2	
Sand, fine-grained, light yellowish-brown, calcareous, base concealed.		6

Sand of a similar character is exposed in a road cut along State Highway No. 10, 1½ miles west of Mason City, in the SE. ¼ SW. ¼ SE. ¼ sec. 2, T. 20 N., R. 6 W., as follows:

	Ft.	in.
Soil, sandy, dark gray	1	
Sand, fine-grained, clayey, dark brownish-gray, noncalcareous (sample 96A)	3	
Sand, fine-grained, light yellowish-brown, noncalcareous (sample 96B)	3	
Sand, fine-grained, yellowish-gray, calcareous		6

The lower 2 feet was penetrated in an auger boring.

All of the samples described above are Albany No. 1 grade sands except sample 96B which might better be classed as a No. 0 sand although it is close to the boundary between the No. 0 and No. 1 grade sands.

Tests on samples 51 and 96A are given in table 9 (p 24), and sieve analyses of samples 52 and 96B are given in table 13 (p. 48). Sample 51 is similar in grain size

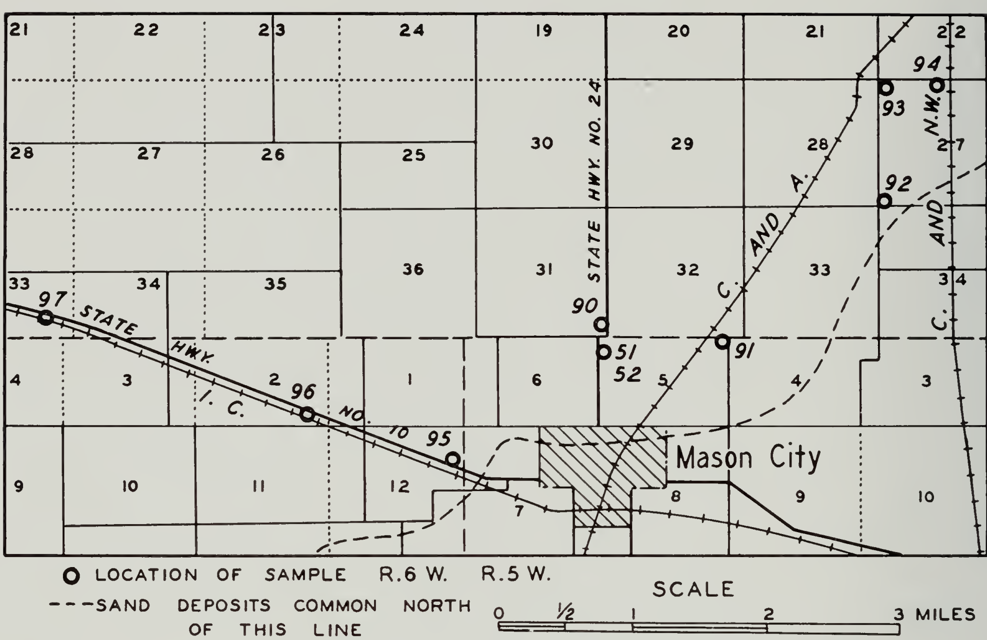

FIG. 5—Locations of samples collected near Mason City in Mason County.

to the average Albany No. 1 grade sand (table 2, p. 9). If 8 to 10 per cent of the pan material were retained on the 270-mesh sieve, the grain size would match the average for the grade very closely. The sample has a green permeability of 17.6 at 7.4 per cent water which is average for the No. 1 grade, and its green compressive strength of 7.4 pounds per square inch at 7.4 per cent water is also average. The overlying 2 feet 6 inches of sand (sample 52) is similar in grain size but contains a higher amount of A.F.A. clay than the lower sand. At least a part of the upper sand could probably be included with the lower sand without changing its properties appreciably.

Sample 96A has a grain size similar to that of sample 51 but contains a higher percentage of A.F.A. clay. It has a satisfactory permeability of 27.9 at 7.6 per cent water, but is higher than sample 51 in green compressive strength with 14 pounds per square inch at 7.6 per cent water. It contains enough organic matter to color it dark gray. The underlying sand (sample 96B) contains much less A.F.A. clay and would improve the upper sand if mixed with it.

The sand in this area occurs in broad, low sand dunes. The sand is widespread but may be absent in some of the low areas between the dunes. Although the amount of sand of the Albany No. 1 type is uncertain, large quantities may be available inasmuch as similar sand is exposed in other road cuts in the area (samples 97A, 97B, table 13). It will be necessary to make auger borings or test pits to determine the size of the deposits. If the sand is uniform enough in these hills, it is probable that other nearby hills will also be found to contain workable deposits.

The area north of Mason City is about half a mile from the Chicago and Alton Railroad, and the area west of Mason City is along the Illinois Central Railroad.

Deposit near Garden Plain, Whiteside County

Sand similar to the Albany No. 1 grade underlies a terrace about three miles southeast of Garden Plain along the west side of Cattail Slough. The surface of the terrace is about 25 feet above the valley floor. The terrace extends along the valley for about three-quarters of a mile and has a maximum width of nearly one quarter of a mile. The locations where samples were collected are shown in figure 3 (p. 28).

The sand is exposed in a road cut at a lane a short distance south of the railroad in the SE. 1/4 NE. 1/4 NW. 1/4 sec. 32, T. 21 N., R. 4 E., as follows:

	Ft.	in.
Soil, sandy, dark gray	1	
Sand, fine-grained, clayey, dark brown, noncalcareous (sample 39A)	2	6
Sand, similar to above but much less clayey, noncalcareous (sample 39B)	3	
Silt, clayey, brown, noncalcareous, penetrated in auger boring, base not reached	1	

About an eighth of a mile north of this section the sand is also exposed in a road cut along the north side of the road, 100 feet east of the railroad, in the SE. 1/4 SE. 1/4 SW. 1/4 sec. 29, T. 21 N., R. 4 E., as follows:

	Ft.	in.
Soil, sandy, dark gray	1	
Sand, clayey, brown; lower 2 feet slightly more clayey than above (sample 84A)	3	
Sand, fine-grained, less clayey than above, brown, noncalcareous; lower 2 feet was penetrated in an auger boring (sample 84B)	5	
Silt, brown, noncalcareous, base not reached		6

The tests of sample 39A are given in table 9 (p. 24), and the sieve analyses of samples 39B, 84A, and 84B are given in table 13, (p. 48). These samples are all similar in grain size to the Albany No. 1 grade. Sample 39A has a permeability of 22.4 at 8 per cent water which is above the average for Albany sands of that grade. The sample has a high green compressive strength of 13.8 pounds per square inch at 8 per cent water. The underlying sand (sample 39B) has a lower clay content but is otherwise similar in grain size. Including it with the upper sand would reduce the strength and increase the permeability. Samples 84A and 84B are similar in grain size to sample 39A but are slightly coarser grained. They are also a little lower in clay content but are well bonded.

Littlefield[17] also examined this deposit and collected two samples (68 and 69, table 12, p. 46) which had a grain size similar to that of samples 39A and 84B. The samples were reported to represent 2 to 3 feet of sand.

Where sampled the terrace appears to contain from 5 to 8 feet of workable sand below an overburden of about 1 foot of soil. Prospecting by test pitting or auger boring is necessary to determine how large an area of the terrace is underlain by sand similar to that described. Judging from the similarity of the sand in the two road cuts, a considerable quantity of uniform sand is probably available.

The area is crossed by the Chicago, Burlington and Quincy Railroad.

Deposit near Fenton, Whiteside County

Fine-grained sand occurs in low dunes along the west side of Cattail Slough, about two miles northwest of Fenton (fig. 3, p. 28). The dunes extend along the base of the bluffs for a little over half a mile.

An auger boring on top of a hill on the east side of the road, about 100 yards southeast of the house near the SE. cor. NW. 1/4 sec. 4, T. 20 N., R. 4 E., penetrated the following materials:

	Ft.	in.
Soil, sandy, brownish-gray		6
Sand, fine-grained, light reddish-brown; noncalcareous (sample 72)	5	6
Sand, similar to above but faintly calcareous; base not reached	1	

Tests of sample 72 are given in table 9 (p. 24). The sample is similar in grain size to the coarser grained sands included in the Albany No. 1 grade. It is lower in the percentage of grains retained on the 270-mesh sieve and a little higher in the percentage retained on the 100-mesh sieve than most No. 1 grade sands. Its grain fineness number of 140 is a little low for the No. 1 grade. The sand might be used also as a No. 1½ grade sand. However, it contains only 5 per cent sand coarser than the 70-mesh sieve which is average for the No. 1 grade, while the average No. 1½ grade contains 20 per cent, and some have 30 per cent coarser than the 70-mesh sieve. The permeability of 24.4 at 6 per cent water is high for the No. 1 grade but a little below average for the No. 1½ grade. If used at 7.9 per cent moisture, the sand would have a permeability of 29.5 which

[17]Littlefield, M. S., op. cit. p. 144

is average for the No. 1½ grade sands. The sand has an average green compressive strength.

The area in which this sand occurs is about half a mile long and its width averages about 200 yards. The sand is probably from 10 to 20 feet thick but only the upper 4 to 6 feet is free from carbonates. Some of the lower sand may be low enough in carbonates to be suitable for some uses, but it may be deficient in bond. Few natural outcrops occur in the area and prospecting by auger borings or test pits is necessary to determine how much of the area is underlain by sand of the type sampled.

The area is adjacent to the Chicago, Burlington and Quincy Railroad.

Deposits at Round Grove, Whiteside County

Fine-grained sand that may be Albany No. 1 grade occurs in a long ridge-like hill at Round Grove, about four miles east of Morrison in Whiteside County. This hill also contains sand similar to the Albany No. 00 grade and the general description of the area and the character of the sand exposed is given in the description of the No. 00 grade sand (p. 26).

Sand similar to the Albany No. 1 grade was sampled in the road cut at Round Grove (sample 73A), where it represents 3½ feet of sand immediately below the soil. The sand differs from the Albany No. 1 grade in several respects. It is lower in content of grains on the 200- and 270-mesh sieves and is a little higher in grains retained on the 100-mesh sieve. However, it contains only 10 per cent of grains coarser than the 70-mesh sieve. This is less than some Albany No. 1 sands and considerably less than most No. 1½ grade sands. The deficiency of the sand in the finer sieve sizes is in part counterbalanced by a slight excess of pan material which accounts for its having a grain fineness number of 166 which is that of an average No. 1 grade sand. This uneven gradation in grain size gives the sand an open texture. It has a permeability of 27.9 at 6.8 per cent water which is higher than that of the Albany No. 1 sands and about average for the No. 1½ grade sands.

Although the entire hill is probably underlain by sand, the greater part of the sand contains carbonates and therefore is not an Albany type sand. Only the sand in the weathered zone, from 4 to 6 feet thick, is free from carbonates. At least part of the hill is covered by several feet of clayey silt which has protected the sand from weathering. Consequently prospecting by means of auger borings or test pits is necessary to determine how large an area of suitable sand is available. The possible presence of similar sand in other nearby hills is referred to elsewhere (p. 27).

OTHER DEPOSITS

In addition to the deposits from which the most promising samples of Albany type sands were collected, many other deposits were examined. As shown by the sieve analyses most of these sands differ in one or more respects from the Albany No. 00, No. 0, or No. 1 grade sands. Many of these sands are probably suitable for some foundry uses, perhaps even for uses where Albany sands are now employed. A large number of the samples are from deposits which were coarser grained than the Albany No. 1 sands and some of them are similar in grain size to the Albany No. 1½ or Albany No. 2 sands. Some of the samples were found to contain too much A.F.A. clay. Others have a radically different gradation from the Albany sands, most commonly being much too low in content of sand retained on the 200- and 270-mesh sieves.

In the following pages the deposits not described elsewhere in more detail are discussed by counties with brief reference to the way in which the samples differ from the Albany type sands. The sieve analysis, location, thickness sampled, thickness of overburden, and other information about each sample is given in table 13 (p. 48). These sieve analyses are probably representative of the finest grained sand available in the areas discussed. A great many exposures were examined and usually samples were collected from the finest sands exposed, although in some areas where it was evident that the sand was too coarse no samples were collected. It was not feasible to examine all the road cuts nor to drill auger borings in all the tracts underlain by sand so it is possible that finer grained sands may be found in these areas by thorough prospecting.

Cook County

During Glacial times, the land now occupied by the City of Chicago and extensive areas surrounding the city were covered by a lake. Large quantities of sand accumulated along the shores of the lake but almost all the sand now exposed in this area is much coarser grained than the Albany No. 1 grade sand. The finest grained sand found (deposit at Lansing, p. 33) occurs between an old shoreline and a sand ridge which was probably an off-shore sand bar in the lake. Similar deposits might be found elsewhere near the old shorelines[18] although several auger borings at favorable localities did not penetrate any fine-grained sand. Sample 11 (table 13) represents the finest grained sand found in several auger borings in the area between the sand ridge extending southeast from Glenwood and the old shoreline at Chicago Heights. It is coarser grained than the Albany No. 1 sand. A considerable area of the old lake bottom is underlain by silt deposits but the noncalcareous zone on these deposits is thin and the material is too clayey for use as a Southern Indiana type sand.

Ford, Grundy, Iroquois, Kankakee, and Will Counties

Large areas in these counties were covered by lakes during the Glacial period and large areas of the old lake bottoms are underlain by sand. In many areas the sand has been blown into dunes, most of which are covered with a thin sandy soil and are now held in place by vegetation. The distribution of the sandy areas is shown on the soil maps of these counties.[19]

The sand deposits in these counties were examined at scores of places but almost without exception were coarser grained than the Albany No. 1 grade sand. At many places the sand is calcareous at a depth of 3 feet and the noncalcareous zone is too clayey as well as too thin to be generally valuable as molding sand. In some areas the soil itself has a grain size not greatly different from that of the Albany sands but it contains a large amount of organic matter including the undecomposed roots of plants. On the sand dunes the soil is thin and usually only a few inches of sand below the humus zone is well bonded. Below that the sand is sharp and incoherent. The upper few feet of the sand is usually noncalcareous and in places as much as 10 feet is noncalcareous.

Descriptions of the samples and sieve analyses are given in table 13. The way in which they differ in grain size from the finer grained Albany sands are given below:

Ford County.—The samples from Ford County are 2, 3AB, 3C, 3D. Sample 2 contains too much clay and has a large amount of organic material. The other samples are too coarse grained.

Grundy County.—The following samples were collected in Grundy County:

99—Too coarse, clay content high.
100—Too coarse.
101—Too clayey; typical of noncalcareous zone on the silty clays which underlie most of the area; might be used for bonding some of the weakly bonded sands.
102, 103, 107—Too coarse.

Iroquois County.—The samples collected from Iroquois County are as follows:

4—Too clayey and coarse.
5—Too coarse.
6 and 6A—Too coarse; similar to samples 55A, 55B, and 55C, but low in bond.
7—Too clayey; low in sand retained on fine sieve sizes.
55A, 55B, and 55C—Too coarse; upper part contains too much clay, lower part, too little clay; average clay content of all three samples is 20 per cent; the average grain fineness number is 110, and the sand probably can be classified as a coarse-grained Albany No. 1½ or a fine-grained Albany No. 2 sand; this appears to be the finest

[18]Locations of the shore lines are shown in the U. S. Geol. Survey Geologic Atlas, Chicago Folio (No. 81), 1902.

[19]Smith, R. S., DeTurk, E. E., Bauer, F. C., Smith, L. H., Ford County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 54, 1933.

Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Grundy County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 26, 1924.

Mosier, J. G., Holt, S. V., Van Alstine, E., and Snider, H. J., Iroquois County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 22, 1922.

Smith, R. S., Ellis, O. I., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Will County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 35, 1926.

Hopkins, C. G., Mosier, J. G., Van Alstine, E., Garrett, F. W., Kankakee County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 13, 1916.

grained sand available in the area, although sand of similar grain size occurs at several places.

56—Similar to samples 55A, 55B, and 55C.

57—Too coarse and clayey.

58A and 58B—Similar in grain size to samples 55A, 55B, and 55C, but lower in bond.

59, 60, 61—Similar to samples 55A, 55B, and 55C, but lower in bond.

Kankakee County.—The samples collected in Kankakee County are 8, 9, and 10. These sands are too coarse grained but are the finest grained sands observed in the county. They are similar in grain size to samples 55A, 55B, and 55C in Iroquois County.

Will County.—Samples 104 and 105 were collected from Will County. Sample 104 was too coarse. Sample 105 is only a little too coarse for the No. 1 grade but the sand is overlain by till which is probably thick except at the outcrop.

Henry County

Much of the northern part of Henry County is underlain by sand but most of these deposits are coarser grained than the Albany No. 1 grade sand. The distribution of the sandy areas is shown in the soil map of Henry County.[20] Samples 47 and 48, collected from this area, represent the finest grained sand found except in the area near Colona (p. 36). Both samples have grain sizes similar to the Albany No. 1½ grade. Descriptions of the samples and sieve tests are given in table 13.

Jo Daviess County

In the vicinity of Blanding[21], about ten miles south of Galena on the east side of Mississippi Valley, several terraces occur at about the same levels as those described at Aiken (p. 36) and may contain similar deposits.

The samples briefly described below were also collected from Jo Daviess County. Locations and sieve analyses are given in table 13.

29—Contains only about 15 per cent grains between 100- and 270-mesh sieves but its relatively high content of pan material gives this sample a grain fineness number of 161, similar to the Albany No. 1 grade sands (fig. 2, p. 23).

32—Contains little bond; this sand is poorly exposed and it is doubtful if a large quantity is available.

Mason County

The greater part of Mason County[22] consists of a large terrace area along Illinois Valley. All the sand examined in the terrace area is medium and coarse grained. The finest grained sand found in Mason County occurs in the upland area in the southeast part of the county and has been described (Mason City area, p. 37). In addition to the samples previously described, the other samples collected in the vicinity of Mason City (fig. 5, p. 38) are listed below with brief comments on the manner in which they differ in grain size from the finer grained Albany sands. Locations and sieve analyses of the samples are given in table 13.

49—Too clayey.

50—Too coarse.

54—Too coarse.

90—Too clayey.

91—Too coarse and clayey.

92A, 92B—Too clayey.

92C—Too coarse.

93A, 93B—Too clayey.

94A, 94B, 95A, 95B, 95C, 97A, 98B—Too coarse.

Rock Island County

Extensive deposits of sand occur in terraces along Rock and Mississippi rivers in Rock Island County.[23] Most of the sand examined on these terraces was much coarser grained than the Albany No. 1 sand. Littlefield[24] reports the production of a fine-grained molding sand from the Mississippi River flats southwest of Rock Island near the junction of Rock and Mississippi

[20]Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Henry County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 41, 1928.

[21]The extent of the terrace is shown in the following report: Trowbridge, A. C. and Shaw, E. W., Geology and Geography of the Galena and Elizabeth quadrangles, Ill.: Illinois State Geol. Survey Bull. 26, Plate IV, 1916.

[22]Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Mason County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 28, 1924.

[23]Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles, Ill.: Illinois State Geol. Survey Bull. 38, Plate 2, 1922.

Smith, R. S., Ellis, O. I., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Rock Island County Soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 31, 1925.

[24]Littlefield, M. S., op. cit., p. 137.

rivers. Tests of two samples (78, 79, table 12) show the sand is similar in grain size to the Albany No. 1 sand although lower in content of grains retained on the 270-mesh sieve. The permeability is low for a No. 1 grade sand. One sample had a large amount of organic bond.

Sample 41 (table 13), collected from an auger boring near School No. 49, two miles northwest of Milan, was a little too coarse grained and also was high in content of A.F.A. clay for a No. 1 grade sand.

Winnebago County

Large areas of terraces along Rock River in Winnebago County[25] are underlain by sand, but that examined was nearly all medium or coarse grained. Similar sand also occurs in terraces along Pecatonica River. Sample 18 (table 13) represents the finest grained sand observed along Pecatonica River. It is too coarse grained and much lower in content of sand between the 100- and 270-mesh sieves than the Albany No. 1 sand. Sample 14 represents a sand deposit on the upland south of Pecatonica but it also is too coarse grained (table 13, p. 48).

Southern Indiana Type Sands

PROMISING DEPOSITS

Sands of the Southern Indiana type usually have a grain fineness number of more than 250 and contain from 5 to 30 per cent A.F.A. clay (p. 14). Of the samples collected, 37 have a grain fineness number higher than 250, but 20 of these have more than 30 per cent A.F.A. clay and two are calcareous, leaving 15 samples which meet the above requirements (table 6, p. 18). Fourteen of these samples were collected from the loess deposits in the Mississippi Valley bluffs and adjacent upland areas in Whiteside and Rock Island counties. One sample is from Jo Daviess County. Similar deposits are present in and near the Mississippi Valley bluffs almost continuously from East Dubuque to Rock Island and probably also farther south along Mississippi Valley.

[25]Bretz, J Harlen, Geology and mineral resources of the Kings quadrangle, Ill.: Illinois Geol. Survey Bull. 43, 1923.
Hopkins, C. G., Mosier, J. G., Van Alstine, E., Garrett, F. W., Winnebago County soils: Univ. Illinois Agr. Exper. Station, Soil Report No. 12, 1916.

The calcareous loess has been used for molding sand and was produced in pits near Rock Island and Galena. Because of the presence of carbonates not much of this material has been used and there is no consistent production. Samples of the calcareous loess from Rock Island and Galena are 63 and 102 respectively (table 12, p. 46).

The following samples meet the grain size requirements for the Southern Indiana type sands: 34, 35, 36, 36A, 37, 40, 42, 74, 77B, 80A, 80B, 81B, 86B, 87, 88B. The above samples are all similar in grain size except for variations in the amount of A.F.A. clay. Consequently green permeability and compressive strength tests were made on three samples which show the range in A.F.A. clay content commonly found in these deposits. The samples tested are 36, which had 23.2 per cent A.F.A. clay, 80A, which had 26.8 per cent A.F.A. clay, and 44, which had 30.4 per cent A.F.A. clay. These samples were collected at the localities described below.

In a road cut about four miles northeast of Fulton at the top of the bluffs near the center of the NE. 1/4 sec. 19, T. 22 N., R. 4 E. (Whiteside County), the following beds are exposed:

	Ft.	in.
Silt, dark brown	1	
Silt, sandy, brown, noncalcareous; the upper 1 foot 8 inches is more clayey than below (sample 36 represents the entire thickness, sample 36A, the lower 3 feet)	4	8
Silt, sandy, light yellowish-brown, calcareous, base concealed (sample 36B from upper 3 feet)	5	

In a road cut on the south side of U. S. Highway No. 30, three miles east of Fulton at the sharp curve in the road in the NW. 1/4 SW. 1/4 SE. 1/4 sec. 30, T. 22 N., R. 4 E., (Whiteside County) the following beds are exposed:

	Ft.	in.
Soil, brown	1	
Silt, clayey, brown, noncalcareous (sample 80A)	5	
Silt, similar to above but upper 2 feet slightly more clayey (sample 80B)	3	6
Silt, brownish-gray, calcareous	1	
Sand, light gray, medium-grained, calcareous, base concealed	2	

The following beds are exposed about two miles northwest of Hillsdale in a road

Table 11.—Tests of Southern Indiana Type Sands from Northern Illinois

Sample number	County	Sieve Analysis, Per Cent Retained on Sieve										Grain fineness number	Water (per cent)	Permeability	Green compressive strength lbs. sq. in.
		40	50	70	100	140	200	270	Pan	Clay	Total				
36	Whiteside.....	Tr	Tr	0.2	0.4	0.8	2.2	1.8	71.4	23.2	100.0	289	5.0	4.3	18.2
													6.6	6.5	14.8
													8.0	5.9	12.6
44	Rock Island...	Tr	Tr	Tr	0.2	0.4	1.4	3.0	64.6	30.4	100.0	291	4.3	1.7	22.0
													6.1	4.3	16.1
													6.9	5.8	16.8
													8.6	9.9	13.9
80A	Whiteside.....	Tr	Tr	0.2	0.2	0.4	1.4	2.0	69.0	26.8	100.0	292	3.9	2.4	21.5
													6.1	4.9	18.1
													8.6	6.5	14.0

cut at the top of a hill, 50 yards north of an angle in the road, in the SE. ¼ SE. ¼ NW. ¼ sec. 18, T. 19 N., R. 3 E. (Rock Island County):

	Ft.	in.
Soil, brown......................		8
Silt, clayey, brown, noncalcareous (sample 44)..................	3	9
Silt, light brown, calcareous, base concealed.....................	3	

The locations where samples 36 and 80A were collected are shown on figure 3 (p. 28).

The tests of samples 36, 44, and 80A are given in table 11 (p. 44), and the sieve analyses of the other samples are given in table 13 (p. 48). The samples tested have a permeability as high as or a little higher than many of the Southern Indiana sands. The samples have a compressive strength higher than that of the sample of Southern Indiana sand tested (FS, table 4, p. 12).

By far the greater part of the loess which mantles the bluffs and uplands near Mississippi Valley is highly calcareous and therefore unsuited for many foundry uses. In these deposits, as in the Albany type sand deposits, weathering has leached the carbonates from the upper 4 to 8 feet of the loess. In this zone the solutions percolating downward not only dissolve the carbonates but at the same time carry clay downward from the surface soil and deposit it in the upper part of the silt. As a result the noncalcareous zone, and especially the part immediately below the soil, contains more clay than the underlying calcareous material. In some of the deposits examined the calcareous, unweathered material contains a relatively low amount of A.F.A. clay, as sample 36B, which has 12.2 per cent A.F.A. clay, and sample 108, which has 15.6 per cent A.F.A. clay. The lower part of the noncalcareous zone usually contains from 15 to 25 per cent A.F.A. clay, and the upper 1 to 2 feet contains 5 to 15 per cent more A.F.A. clay. Therefore it may be desirable in working many deposits to omit the upper 1 to 2 feet below the soil, which would leave from 2 to 5 feet of noncalcareous silt with a relatively low A.F.A. clay content. A few samples representing the entire noncalcareous zone contain more than 40 per cent A.F.A. clay and at these places it is doubtful if a material with low clay content can be produced.

The most promising areas are those shown on the soil maps of Whiteside[26] and Rock Island[27] counties as mixed sand and loess, fine sandy loam, and fine sandy silt loam. These areas include the greater part of the upland areas within ten miles of the Mississippi River bluffs. Within these areas the deposits nearer the Mississippi bluffs appear to be slightly less clayey and more sandy, characteristics which are desirable to a cer-

[26]Smith, R. S., Ellis, O. I., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Whiteside County soils: Univ. Illinois Agr. Exper. Station Soil report No. 40, 1928.

[27]Smith, R. S., Ellis, O. I., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Rock Island County soils: Univ. Illinois Agr. Exper. Station Soil report No. 31, 1925.

tain extent as they tend to increase the permeability and decrease the strength of the sand.

The similarity of the sieve analyses of the samples collected at widely separated places indicates that the material is fairly uniform in grain size. However, the need for carefully prospecting a proposed site for a commercial operation is shown by the presence in the uplands of areas where the silt is covered by medium-grained sand. Also, in some areas the noncalcareous zone is too high in A.F.A. clay content for a Southern Indiana type sand, and at others the zone with low A.F.A. clay content may be too thin or covered with a comparatively thick overburden of silty clay.

Many areas favorable for prospecting occur along the paved highways and along the railroads, especially the Chicago, Burlington and Quincy Railroad, east of Fulton, near Garden Plain, Hillsdale, and Barstow; along the Chicago, Milwaukee and St. Paul Railroad near Albany, Port Byron, and Hampton; and along the Chicago and Northwestern Railroad east of Fulton, near Union Grove and Morrison. Similar deposits probably are present at many other places farther north near Savanna in Carroll County, and near Galena in Jo Daviess County.

OTHER DEPOSITS

Some of the Albany type sand deposits described are overlain by several feet of noncalcareous silt which is similar to the Southern Indiana sand but contains more than 30 per cent A.F.A. clay. Although the typical Southern Indiana sands contain less than 30 per cent A.F.A. clay, many analyses have been published of sands containing more than 30 per cent A.F.A. clay, which have been produced on a commercial scale. Another possible use for these materials is for blending with other sands deficient in bond. This use would be limited to those sands to which adding silt, as well as the clay, would not be detrimental. Where sands high in clay content form the overburden on a valuable sand, and could be produced cheaply, it is possible that some outlet for them could be found in the foundry trade. Deposits of this kind are represented by samples 26 (overlying sample 25, p. 29) and 31 (overlying sample 30, p. 23).

Other samples containing 30 to 40 per cent clay are 33, 43, 44, 65C, 67B, 68A, 77A, 79, 81A, 83, 86A, and 88A. Descriptions of these samples and their sieve analyses are given in table 13 (p. 48). These samples are all from the area near Mississippi Valley and most of them were collected from the entire noncalcareous zone, omitting only the soil. Since a good many of them contain only slightly more than 30 per cent A.F.A. clay, it is probable that a material with less than 30 per cent A.F.A. clay can be produced if the upper clayey zone, or part of it immediately below the soil, is removed with the soil as overburden.

A few samples from the same area representing the entire noncalcareous zone contain over 40 per cent A.F.A. clay. It is doubtful if a material with low clay content can be produced at the places where these samples were collected. Samples with more than 40 per cent A.F.A. clay are 66, 71, 85, and 89.

The noncalcareous portion of the loess deposits examined farther east from Mississippi Valley is in all cases high in A.F.A. clay, usually more than 40 per cent. Samples 20 and 22 (table 13) are typical of this material in Winnebago County.

TABLE 12.—PREVIOUS TESTS OF FINE-GRAINED MOLDING SANDS FROM NORTHERN ILLINOIS[1]

Sample number	County	Sieve Analysis—Per Cent Retained on Sieve									Grain fineness number	Water (per cent)	Perme-ability	Bond strength
		40	70	100	140	200	270	Pan	Clay	Total				
61	Jo Daviess		2.0	6.0	9.4	26.4	9.0	27.4	19.4	99.6	188	4	11.2	317.7
												6	12.2	297.8
												8	10.9	287.5
62	Jo Daviess		23.6	27.0	18.0	15.0	2.6	4.8	8.0	99.0	97	4	52.2	220.4
												6	44.0	152.4
												8	41.8	130.7
63	Jo Daviess		0.4	0.5	1.0	4.2	4.2	69.8	19.0	99.1	282	4	2.6	219.2
												6	3.3	256.6
												8	3.4	227.7
65	Whiteside		11.0	18.0	13.4	14.0	5.4	30.8	6.8	99.4	166	4	12.2	154.1
												6	12.9	138.3
												8	13.4	143.3
66	Whiteside		11.0	11.8	8.8	13.0	7.0	39.2	8.2	99.2	189	4	8.1	247.4
												6	9.0	172.2
												8	10.0	154.2
68	Whiteside		3.9	13.0	12.8	23.8	8.2	26.0	12.2	99.9	173	4	15.3	275.6
												6	14.7	322.9
												8	13.6	302.4
69	Whiteside		2.2	10.8	17.0	25.0	8.2	20.6	15.4	99.2	166	4	13.7	245.0
												6	14.1	222.6
												8	13.9	196.1
78	Rock Island		5.1	9.4	18.5	22.8	9.6	26.0	7.4	98.8	171	4	10.3	190.8
												6	10.3	197.2
												8	10.0	199.1
79	Rock Island	2.4	8.8	7.6	11.4	17.8	5.6	25.4	20.0	99.0	208	4	14.3	
												6	14.5	203.7
												8	11.0	213.4

94	Henry	0.4	17.4	17.8	18.0	19.6	4.0	10.0	12.0	99.2	119	4	36.4	198.0
												6	34.8	188.4
												8	30.9	156.6
95	Henry		5.0	11.8	21.6	28.4	5.8	11.9	14.7	99.2	146	4	23.2	251.7
												6	27.8	262.4
												8	20.4	228.1
102	Rock Island		0.6	0.8	1.2	4.2	4.4	78.8	9.7	99.7	281	4	4.1	181.3
												6	4.4	197.8
												8	4.7	173.8
110	Rock Island	1.2	9.8	7.1	7.4	11.8	19.8	33.8	8.2	99.1	192	4	4.4	236.4
												6	4.6	271.4
												8	4.7	261.8

[1]From Littlefield, M. S., Natural bonded molding sand resources of Illinois: Illinois State Geol. Survey Bull. 50, pp. 165–171, 1925.

TABLE 13.—DESCRIPTIONS AND SIEVE ANALYSES OF

Sample number	LOCATION: County	LOCATION: Town near	Section: ¼	Section: ¼	Section: ¼	Section	Township	Range	Thickness sampled: Ft.	Thickness sampled: in.	OVERBURDEN: Thickness: Ft.	OVERBURDEN: Thickness: in.	OVERBURDEN: Material[1]	Underlying material[1]
1	Iroquois	Ridgeville		SE	cor.	16	26 N	10 E	1	6	.....		....	Sandy clay
2	Ford	Piper City		SE	cor.	3	27 N	9 E	1		.....		....	Silty clay
3AB	Ford	Piper City		SE	cor.	2	27 N	9 E	1	5	.....		....	3C
3C	Ford	Piper City		SE	cor.	2	27 N	9 E	1		1	5	3AB	3D
3D	Ford	Piper City		SE	cor.	2	27 N	9 E	1	2	2	5	3AB, 3C	Coarser sand
4	Iroquois	Gilman	NW	NE	SW	9	26 N	14 W	1	3		6	Soil	More clayey
5	Iroquois	Woodland	SW	SW	SW	13	26 N	13 W	1	6	1	2	Soil	Same—less bond
6	Iroquois	Woodland	SE	SW	SE	18	26 N	12 W	1	6	1	1	Soil	6A
6A	Iroquois	Woodland	SE	SW	SE	18	26 N	12 W	2		2	7	6 and soil	Same
7	Iroquois	Pittwood		NW	cor.	1	27 N	13 W		10	1	2	Soil	Not exposed
8	Kankakee	St. Anne	NE	cor.	NW	33	30 N	12 W	2		1	3	Soil	Same—less bond
9	Kankakee	Otto	SW	SW	SE	25	30 N	14 W	1	6		10	Soil	Same—less bond
10	Kankakee	Union Hill	NE	NE	NE	6	30 N	10 E	2			6	Soil	Same—less bond
11	Cook	Chicago Heights	NE	NW	SE	23	35 N	14 E	1	10	2	10	Soil and silt	Calcareous silt
12	Cook	Lansing		SE	cor.	31	36 N	15 E	1	2		4	....	Same—less bond
14	Winnebago	Pecatonica	SW	SW	SW	33	27 N	10 E	2		1		Soil	Calcareous sand
18	Winnebago	Harrison	SW	SW	SE	15	28 N	11 E	4		1	2	Soil	Not exposed
20	Winnebago	Roscoe	NE	NE	SE	24	46 N	2 E	4		1		Soil	Not exposed
22	Winnebago	Roscoe	NE	NE	NW	6	45 N	2 E	3		1	6	Soil	Not exposed
25	Whiteside	Lyndon			cen.	7	20 N	5 E	4		5		26 and soil	25B
25A	Whiteside	Lyndon			cen.	7	20 N	5 E	4		4	6	Silt and soil	....
25B	Whiteside	Lyndon			cen.	7	20 N	5 E	3	6	9		25, 26, and soil	Calcareous sand
26	Whiteside	Lyndon			cen.	7	20 N	5 E	3		2		Soil and silt	25
27	Jo Daviess	Galena	SE	SW	NW	9	27 N	1 E	2			8	Soil	Clayey silt
28A	Jo Daviess	Galena	SE	NW	SW	9	27 N	1 E	2	10		8	Soil	28B
28B	Jo Daviess	Galena	SE	NW	SW	9	27 N	1 E	2	6	3	6	28A and soil	28C
28C	Jo Daviess	Galena	SE	NW	SW	9	27 N	1 E	1	6	6		28A, 28B, and soil	Sand and silt
29	Jo Daviess	Galena	SW	NE	NE	9	27 N	1 E	2		1		....	Same—less bond
30	Jo Daviess	Galena	NW	NE	NE	22	27 N	1 E	3		3	2	31 and soil	Calcareous silt
31	Jo Daviess	Galena	NW	NE	NE	22	27 N	1 E	2	6		8	Soil	30
32	Jo Daviess	Hanover	SW	SW	SW	7	26 N	2 E	3		2		Soil and clay	Calcareous sand
33	Carroll	Savanna			NE	1	25 N	2 E	3		1	6	Soil	Medium sand
34	Whiteside	Morrison	SW	NW	NE	1	21 N	4 E	2	6	3		Soil and clayey silt	Calcareous silt
35	Whiteside	Morrison	NE	SW	SW	22	22 N	4 E	3		2		Soil and clayey silt	Not exposed
36	Whiteside	Fulton		cen.	NE	19	22 N	4 E	4	8	1		Soil	36B
36A	Whiteside	Fulton		cen.	NE	19	22 N	4 E	3		2	8	Soil and clayey silt	36B
36B	Whiteside	Fulton		cen.	NE	19	22 N	4 E	5	8	.....		36 and soil	Same
37	Whiteside	Union Grove	SE	NE	NE	9	21 N	4 E	4		2		Soil and clayey silt	Calcareous silt
38	Whiteside	Lyndon	NW	NE	NW	18	20 N	5 E	2	4		6	Soil	Same—more clayey
39A	Whiteside	Garden Plain	SE	NE	NW	32	21 N	4 E	2	6	1		Soil	39B
39B	Whiteside	Garden Plain	SE	NE	NW	32	21 N	4 E	3		3	6	39A and soil	Clayey silt
40	Whiteside	Garden Plain		SW	cor.	10	21 N	3 E	4		1	3	Soil	Calcareous silt
41	Rock Island	Milan	SW	cor.	NW	15	17 N	2 W	2	6	1		Soil	Sand—little bond
42	Rock Island	Barstow	cen.	NW	NW	23	18 N	1 E	2	6		10	Soil	Calcareous silt
43	Rock Island	Port Byron		cen.	NW	31	19 N	2 E	3		1	6	Soil	Calcareous silt
44	Rock Island	Hillsdale	SE	SE	NW	18	19 N	3 E	3	9		8	Soil	Calcareous silt
45	Henry	Colona	SE	SE	SW	11	17 N	1 E	1	4		8	Soil	Same—less bond
47	Henry	Atkinson	NE	NW	NE	10	17 N	4 E	2			6	Soil	Same—less bond
48	Henry	Hooppole		cen.	NE	22	18 N	5 E	2	6	1		Soil	Same—less bond
49	Mason	San Jose	NW	NE	NW	1	21 N	5 W	2		1	6	Soil	Medium sand
50	Mason	Mason City	SE	SE	SE	7	21 N	5 W	2	6	1		Soil	Same—less bond
51	Mason	Mason City	NW	NW	NW	5	20 N	5 W	2		3	6	52 and soil	Same—calcareous
52	Mason	Mason City	NW	NW	NW	5	20 N	5 W	2	6	1		Soil	51
54	Mason	Easton			cen.	20	20 N	7 W	2		.....		....	Probably same
55A	Iroquois	Onarga	NE	SE	SE	23	26 N	10 E	2			4	Soil	55B
55B	Iroquois	Onarga	NE	SE	SE	23	26 N	10 E	1	6	2	4	55A and soil	55C
55C	Iroquois	Onarga	NE	SE	SE	23	26 N	10 E	2	6	3	10	55A, 55B, and soil	Coarser sand
56	Iroquois	Ridgeville	NW	NE	SE	22	26 N	10 E	2		3		Soil and clayey sand	Not exposed
57	Iroquois	Ridgeville	SE	SW	SE	15	26 N	10 E	2	6		6	Soil	Coarser sand
58A	Iroquois	Woodland	NE	NE	NW	20	26 N	12 W	5			6	Soil	Same—less bond

[1]Where the overburden or underlying material has been sampled and a sieve analysis is available, the number of the sample is given.

"Same" in the column "Underlying material" means that the material underlying the sample is the same as the sample, the sieve analysis of which is given on the opposite page.

Samples of Molding Sands from Northern Illinois

Sample number	Remarks	Sieve analysis, per cent retained on sieve: 30	40	50	70	100	140	200	270	Pan	Clay	Total	Grain fineness number
1	Auger boring; much organic matter	Tr	0.2	2.0	5.8	10.8	5.8	8.2	4.6	26.0	36.6	100.0	183
2	Auger boring; much organic matter	Tr	0.4	1.4	4.8	12.6	6.0	6.4	5.8	34.4	28.2	100.0	197
3AB	Auger boring; much organic matter	0.4	0.8	3.4	9.0	26.0	12.4	7.6	2.4	12.4	25.2	99.6	120
3C	Auger boring; much organic matter	0.4	0.8	2.6	7.6	17.8	9.2	5.6	2.0	15.0	39.0	100.0	137
3D	Auger boring; much organic matter	0.6	0.8	3.2	10.2	28.6	14.2	9.0	3.4	8.4	21.4	99.8	109
4	Road cut	0.2	0.6	2.8	8.4	20.4	8.2	7.0	1.6	17.8	32.6	99.6	140
5	Road cut	Tr	0.2	2.0	8.2	25.2	20.2	18.0	4.4	8.8	13.0	100.0	119
6	Road cut	Tr	0.2	2.4	10.4	32.6	19.8	18.6	4.2	5.6	5.8	99.6	107
6A	Road cut	0.4	0.4	3.2	12.0	36.0	19.4	15.8	4.4	4.0	4.2	99.8	99
7	Ditch along road	Tr	0.4	1.2	3.6	17.0	11.4	9.8	3.6	19.0	34.0	100.0	157
8	Ditch along road	Tr	0.6	5.2	14.0	38.6	16.0	7.6	2.2	6.0	9.8	100.0	94
9	Auger boring W. of R. R.	0.2	0.6	5.8	16.6	32.4	10.6	5.8	1.6	8.6	17.4	99.6	99
10	Road cut	Tr	0.8	6.2	12.4	28.0	17.4	16.6	4.0	6.4	8.0	99.8	105
11	Auger boring	0.4	1.6	5.6	10.6	33.2	16.0	6.0	1.4	9.0	16.0	99.8	102
12	Auger boring	Tr	0.6	1.8	5.4	23.0	32.0	15.0	2.2	5.8	14.0	99.8	110
14	Road cut	0.2	1.2	7.2	12.4	22.2	9.0	5.0	2.0	16.0	24.4	99.6	115
18	Road cut	0.4	1.8	8.8	12.6	19.8	8.0	3.2	1.0	14.0	29.6	99.2	116
20	Road cut	Tr	0.2	0.8	1.2	1.4	0.6	0.6	1.0	43.0	51.2	100.0	276
22	Road cut	0.2	0.8	4.0	5.4	5.6	2.0	1.8	1.2	41.0	37.8	99.8	223
25	Road cut S. of school	Tr	0.4	1.8	2.6	7.4	10.6	17.0	13.4	40.8	6.0	100.0	192
25A	Auger boring E. of road cut	Tr	Tr	0.8	1.4	4.2	6.0	14.0	10.8	50.4	12.0	99.6	211
25B	Road cut S. of school; part slightly calcareous	Tr	0.2	2.0	3.4	15.6	20.2	24.8	11.0	20.2	2.4	99.8	155
26	Road cut S. of school	..	Tr	Tr	0.2	0.2	0.2	0.8	1.2	53.0	44.4	100.0	293
27	Road cut	0.2	0.2	0.4	0.8	6.4	9.2	13.6	7.0	31.8	30.2	99.8	205
28A	Road cut E. of R. R.	0.2	1.2	3.6	5.0	17.8	17.2	14.4	5.2	20.6	15.6	100.8	148
28B	Auger boring	Tr	Tr	1.2	4.0	13.8	13.6	14.6	7.2	30.6	15.0	100.0	179
28C	Auger boring	Tr	Tr	0.8	2.4	15.4	22.6	21.2	9.6	20.8	7.4	100.2	157
29	Road cut N. of school	0.2	1.4	6.8	10.0	17.6	7.0	5.2	2.8	30.2	18.8	100.0	161
30	Road cut	....	Tr	0.4	1.6	8.0	7.6	11.4	6.6	46.0	18.4	100.0	226
31	Road cut	....	Tr	0.2	0.8	3.2	3.2	5.2	2.4	52.8	32.4	100.2	260
32	Road cut near house	1.0	1.6	3.0	4.4	8.2	8.4	15.0	11.8	44.2	2.6	100.2	200
33	Road cut and auger boring	....	Tr	0.2	0.4	1.2	1.6	1.4	1.4	54.0	39.6	99.8	282
34	Road cut	....	Tr	0.2	0.4	1.2	1.2	3.0	3.2	69.0	21.8	100.0	281
35	Road cut	Tr	Tr	0.2	0.6	0.6	0.8	2.0	2.0	64.8	28.6	99.6	286
36	Road cut	....	Tr	Tr	0.2	0.4	0.8	2.2	1.8	71.4	23.2	100.0	289
36A	Road cut	....	Tr	Tr	0.2	0.6	1.0	2.4	2.2	73.6	20.0	100.0	288
36B	Road cut; calcareous	....	Tr	Tr	0.2	0.2	0.6	1.6	1.4	84.0	12.2	100.2	293
37	Road cut	....	Tr	0.8	2.0	3.8	2.2	0.6	7.4	56.4	26.6	99.8	261
38	Road cut	....	Tr	Tr	0.2	2.8	8.2	15.8	11.0	39.6	22.2	99.8	222
39A	Road cut S. of R. R.	....	Tr	0.2	2.4	15.2	16.0	15.0	7.2	24.8	19.0	99.8	170
39B	Road cut and auger boring	...	Tr	0.4	2.6	16.8	17.8	18.4	5.2	30.4	8.2	99.8	173
40	Road cut	...	....	Tr	Tr	0.4	0.6	1.6	2.8	65.0	29.8	100.2	290
41	Auger boring	1.2	2.0	2.8	4.4	12.8	8.6	6.6	3.8	29.4	29.2	100.8	177
42	Road cut	...	Tr	Tr	Tr	0.6	0.4	1.4	1.6	70.0	26.0	100.0	293
43	Road cut	...	Tr	0.2	0.2	0.6	1.6	3.4	2.8	56.2	34.6	99.6	279
44	Road cut	...	Tr	Tr	Tr	0.2	0.4	1.4	3.0	64.6	30.4	100.0	291
45	Road cut	Tr	Tr	0.6	3.6	36.6	21.0	12.6	4.0	10.4	10.8	99.6	117
47	Road cut	Tr	1.6	11.2	13.6	22.8	18.8	15.6	4.0	5.4	6.8	99.8	100
48	Road cut	0.2	1.8	5.6	4.6	4.2	2.0	1.8	1.8	41.6	36.2	99.8	222
49	Road cut	Tr	0.8	3.6	5.8	7.0	2.4	2.4	2.0	38.0	38.0	100.0	215
50	Road cut	Tr	0.8	7.6	16.8	33.2	12.8	7.2	2.0	7.8	11.4	99.6	97
51	Road cut	Tr	Tr	0.8	3.8	16.4	15.0	14.0	8.6	26.4	14.6	99.6	169
52	Road cut	...	Tr	0.8	4.0	15.4	12.6	11.0	5.2	26.4	24.0	99.4	155
54	Road cut	...	Tr	4.4	25.6	51.6	9.8	3.0	0.6	1.8	2.8	99.6	74
55A	Auger boring	Tr	0.4	2.8	9.8	24.8	12.0	9.4	2.6	9.8	28.4	100.0	116
55B	Auger boring	Tr	0.4	2.4	8.2	26.4	13.6	10.0	0.2	12.0	26.8	100.0	120
55C	Auger boring	Tr	1.0	6.8	15.4	32.2	15.0	12.4	3.2	5.0	8.8	99.8	96
56	Road cut	Tr	0.4	2.8	11.2	29.4	13.0	11.8	3.8	7.8	19.8	100.0	110
57	Auger boring E. of R. R.; much organic matter	Tr	0.6	3.4	10.2	23.2	10.0	8.2	2.6	11.2	30.4	99.8	120
58A	Road cut	Tr	0.2	3.8	11.8	30.4	21.0	18.8	6.6	2.6	4.8	100.0	102

TABLE 13—

Sample number	LOCATION: County	Town near	Section ¼	¼	¼		Township	Range	Thickness sampled Ft.	in.	OVERBURDEN: Thickness Ft.	in.	Material[1]	Underlying material[1]
58B	Iroquois	Woodland	NE	NE	NW	20	26 N	12 W	2		12		Sand, including 58A.	Calcareous sand
59	Iroquois	Pittwood	SE	SW	NW	5	27 N	12 W	2			8	Soil	Same—less bond
60	Iroquois	Pittwood	NE	NW	NE	4	27 N	12 W	2			6	Soil	Same—less bond
61	Iroquois	Pittwood	NE	NE	NE	33	28 N	12 W	2			6	Soil	Not exposed
62	Cook	Chicago Heights	SE	cor.	NE	16	35 N	14 E	2	6	1		Soil	Calcareous clay
63	Cook	Lansing		SW	cor.	36	36 N	14 E	3		1		Soil	Slightly calcareous sand
63A	Cook	Lansing		SW	cor.	36	36 N	14 E	2	4	1		Soil	63B
63B	Cook	Lansing		SW	cor.	36	36 N	14 E		8	3	4	63A and soil	Slightly calcareous sand
64	Cook	Lansing	NW	NW	SW	36	36 N	14 E	5			6	Soil	Same
65A	Whiteside	Lyndon	NE	NE	SW	19	20 N	5 E	2	6		8	Soil	65B
65B	Whiteside	Lyndon	NE	NE	SW	19	20 N	5 E	1	10	3	2	65A and soil	65C
65C	Whiteside	Lyndon	NE	NE	SW	19	20 N	5 E	6		5		65A, 65B, and soil	Calcareous silt
65AB	Whiteside	Lyndon	NE	NE	SW	19	20 N	5 E	4	4		8	Soil	65C
66	Whiteside	Lyndon	NW	SW	SW	20	20 N	5 E	4	6		8	Soil	Clay and silt
67A	Whiteside	Lyndon	NW	NE	SW	18	20 N	5 E	1	6		6	Soil	67B
67B	Whiteside	Lyndon	NW	NE	SW	18	20 N	5 E	4	3	2		67A and soil	Calcareous medium sand
68A	Whiteside	Lyndon	NE	cor.	SW	18	20 N	5 E	5	6		6	Soil	68B
68B	Whiteside	Lyndon	NE	cor.	SW	18	20 N	5 E	4	6	6		68A and soil	Not reached
69A	Whiteside	Lyndon	SW	NW	SE	18	20 N	5 E	2		1	6	Soil	69B
69B	Whiteside	Lyndon	SW	NW	SE	18	20 N	5 E	3		3	6	69A and soil	Same—calcareous
70	Whiteside	Fenton	NE	SE	NE	14	20 N	4 E	3			6	Soil	Not exposed
71	Whiteside	Fenton	SW	SW	SW	10	20 N	4 E	2	6		10	Soil	Calcareous silt
72	Whiteside	Fenton	SE	SE	NW	4	20 N	4 E	5	6		6	Soil	Same—slightly calcareous
73A	Whiteside	Round Grove	SE	NE	NW	25	21 N	5 E	3	6		6	Soil	73B
73B	Whiteside	Round Grove	SE	NE	NW	25	21 N	5 E	2	6	4		73A and soil	73C
73C	Whiteside	Round Grove	SE	NE	NW	25	21 N	5 E	8		6	6	73A, 73B, and soil	Not exposed
74	Whiteside	Round Grove	SW	SW	NW	30	21 N	6 E	3	6	1		Soil	Calcareous silt
75	Whiteside	Morrison	NE	SW	SW	16	21 N	5 E	2	8	1		Soil	Calcareous sand
77A	Jo Daviess	Galena	SE	SW	NW	15	27 N	1 E	4	6		6	Soil	77B
77B	Jo Daviess	Galena	SE	SW	NW	15	27 N	1 E	3		5		77A and soil	Pebbly silt
78A	Jo Daviess	Galena	cen.	SE	SW	9	27 N	1 E	2	9		6	Soil	78B
78B	Jo Daviess	Galena	cen.	SE	SW	9	27 N	1 E	3		3	6	78A and soil	Sandy silt
79	Whiteside	Fulton	NE	SE	NE	4	22 N	4 E	8		1		Soil	Pebbly clay
80A	Whiteside	Fulton	NW	SW	SE	30	22 N	4 E	5		1		Soil	80B
80B	Whiteside	Fulton	NW	SW	SE	30	22 N	4 E	3	6	6		80A and soil	Calcareous silt
81A	Whiteside	Union Grove	SE	NE	NE	33	22 N	4 E	3	6	1		Soil	81B
81B	Whiteside	Union Grove	SE	NE	NE	33	22 N	4 E	2	9	4	6	81A and soil	Calcareous silt
82	Whiteside	Union Grove	NE	SE	SW	32	22 N	4 E	2	9		9	Soil	Medium sand
83	Whiteside	Morrison	NE	SE	SW	11	21 N	4 E	5			8	Soil	Clayey silt
84A	Whiteside	Garden Plain	SE	SE	SW	29	21 N	4 E	3		1		Soil	84B
84B	Whiteside	Garden Plain	SE	SE	SW	29	21 N	4 E	5		4		84A and soil	Silt
85	Whiteside	Garden Plain		NE	cor.	31	21 N	4 E	3	2		9	Soil	Calcareous clayey silt
86A	Whiteside	Fulton	NW	SW	SW	36	22 N	3 E	2		1		Soil	86B
86B	Whiteside	Fulton	NW	SW	SW	36	22 N	3 E	3	6	3		86A and soil	Calcareous sandy silt
87	Whiteside	Fulton	cen.	NW	NE	19	22 N	4 E	5		1		Soil	Calcareous sandy silt
88A	Whiteside	Albany	cen.	SE	SE	17	21 N	3 E	3			6	Soil	Calcareous silt
88B	Whiteside	Albany	cen.	SE	SE	17	21 N	3 E	2	8	3	6	88A and soil	Calcareous silt
89	Rock Island	Hillsdale	SW	SE	SW	19	19 N	3 E	4	6	1		Soil	Calcareous silt
90	Mason	Mason City	SE	SE	SE	31	21 N	5 W	2	6	1		Soil	Medium sand
91	Mason	Mason City		NE	cor.	5	20 N	5 W	2	6		6	Soil	Clayey silt
92A	Mason	Mason City		SW	cor.	27	21 N	5 W	1	6		6	Soil	92B
92B	Mason	Mason City		SW	cor.	27	21 N	5 W	1		2		92A and soil	92C
92C	Mason	Mason City		SW	cor.	27	21 N	5 W	2		3		92A, 92B, and soil	Coarser sand
93A	Mason	Mason City	NW	NW	NW	27	21 N	5 W	1	6		6	Soil	93B
93B	Mason	Mason City	NW	NW	NW	27	21 N	5 W	3		2		93A and soil	Calcareous silt
94A	Mason	Mason City	SE	SE	SW	22	21 N	5 W	3		6		Soil	94B
94B	Mason	Mason City	SE	SE	SW	22	21 N	5 W	1	6	3	6	94A and soil	Not exposed

[1]Where the overburden or underlying material has been sampled and a sieve analysis is available, the number of the sample is given.

"Same" in the column "Underlying material" means that the material underlying the sample is the same as the sample, the sieve analysis of which is given on the opposite page.

CONTINUED

Sample number	Remarks	SIEVE ANALYSIS, PER CENT RETAINED ON SIEVE											Grain fineness number
		30	40	50	70	100	140	200	270	Pan	Clay	Total	
58B	Road cut	Tr	0.2	2.4	9.2	31.4	22.8	21.0	7.0	3.0	2.6	99.6	106
59	Road cut	Tr	0.2	2.4	8.0	31.4	24.8	16.4	3.0	5.4	8.2	99.8	106
60	Road cut	...	Tr	3.0	8.6	31.6	24.2	18.0	2.4	4.6	7.0	99.4	103
61	Road cut	Tr	Tr	2.4	9.4	31.4	24.0	15.6	3.8	4.0	9.8	100.4	103
62	Auger boring	0.4	0.8	1.6	2.2	3.6	2.8	2.6	0.6	14.0	71.4	100.0	190
63	Ditch along road	Tr	0.2	0.4	1.4	23.0	54.4	11.2	1.2	3.2	5.0	100.2	104
63A	Ditch along road	Tr	Tr	0.6	1.2	21.8	53.4	12.4	1.2	2.8	6.6	100.0	105
63B	Ditch along road	Tr	0.2	0.6	2.2	24.4	57.0	11.0	0.8	1.6	2.2	100.0	99
64	Road cut	Tr	0.4	2.0	5.0	35.4	46.8	6.0	0.4	1.2	2.4	99.6	90
65A	Auger boring S. of road cut	....	Tr	Tr	0.6	9.6	18.4	20.8	2.2	33.4	15.0	100.0	187
65B	Auger boring S. of road cut	....	Tr	Tr	0.2	4.2	10.8	17.6	9.8	38.6	19.0	100.2	215
65C	Auger boring S. of road cut	....	Tr	0.2	0.2	1.4	1.8	2.4	1.2	58.8	34.2	100.2	280
65AB	Auger boring S. of road cut	...	Tr	Tr	0.6	7.4	15.0	19.4	9.6	30.4	17.8	100.2	192
66	Auger boring N. of R. R.	Tr	0.2	0.2	Tr	0.4	0.2	0.8	1.0	55.8	41.2	99.8	292
67A	Auger boring	....	Tr	Tr	0.2	3.8	10.2	16.0	9.2	39.8	21.0	100.2	219
67B	Auger boring	...	....	Tr	Tr	0.8	1.2	2.8	2.2	54.8	38.2	100.0	282
68A	Auger boring	...	Tr	Tr	0.2	0.8	1.8	4.0	3.6	52.4	37.2	100.0	275
68B	Auger boring	0.4	1.4	5.0	7.8	23.0	19.6	16.8	7.6	14.8	3.4	99.8	130
69A	Road cut	Tr	Tr	1.4	2.6	7.0	5.0	3.6	0.8	44.0	35.8	100.2	234
69B	Road cut	0.2	1.2	5.2	8.8	23.8	16.8	12.6	4.2	17.8	9.4	100.0	132
70	Road cut	1.0	7.0	27.4	30.0	20.2	4.4	2.4	0.2	2.4	4.6	99.6	61
71	Road cut	..	....	Tr	Tr	0.2	0.2	0.6	0.8	54.4	43.8	100.0	295
72	Auger boring	...	Tr	0.4	4.8	25.6	21.6	16.8	5.0	17.4	8.6	100.2	140
73A	Road cut	Tr	Tr	2.8	8.4	21.2	9.4	7.4	4.2	30.2	16.2	99.8	166
73B	Road cut	Tr	Tr	0.6	2.0	6.4	6.2	10.0	6.4	48.2	20.0	99.8	229
73C	Road cut; calcareous	0.6	1.6	6.6	11.2	19.8	8.6	7.4	5.0	31.6	7.6	100.0	159
74	Road cut	Tr	0.2	0.8	1.8	3.2	1.6	2.6	3.0	60.8	26.0	100.0	266
75	Stream cut S. of road	Tr	0.2	2.2	5.2	8.6	3.6	3.6	2.8	50.0	23.4	99.6	228
77A	Auger boring SW. of hill	....	....	Tr	0.2	0.4	0.6	1.4	1.2	62.0	34.2	100.0	291
77B	Auger boring SW. of hill	....	Tr	0.2	0.4	1.2	1.6	3.6	3.0	63.0	27.0	100.0	278
78A	Auger boring W. of R. R.	Tr	0.6	3.2	7.2	24.2	19.0	13.4	1.2	20.2	10.8	99.8	138
78B	Auger boring W. of R. R.	Tr	Tr	0.6	2.0	12.2	16.6	17.2	5.0	31.6	14.8	100.0	182
79	Road cut	....	Tr	Tr	0.2	0.4	0.2	0.8	0.8	60.2	37.6	100.2	294
80A	Road cut	....	Tr	Tr	0.2	0.2	0.4	1.4	2.0	69.0	26.8	100.0	292
80B	Road cut	....	Tr	Tr	0.2	0.4	0.6	1.4	1.8	69.2	26.6	100.2	291
81A	Road cut	....	....	Tr	0.2	1.0	1.4	3.4	4.2	59.4	30.4	100.0	278
81B	Road cut	...	Tr	0.2	0.8	4.0	3.8	6.6	6.0	59.6	18.8	99.8	256
82	Road cut	Tr	Tr	2.4	4.8	9.2	4.2	4.0	2.8	47.8	24.4	99.6	224
83	Road cut	....	Tr	Tr	Tr	0.6	0.4	1.0	2.0	56.4	39.4	99.8	290
84A	Road cut E. of R. R.	....	Tr	0.4	3.0	21.8	18.4	16.4	6.6	21.6	11.6	99.8	155
84B	Road cut E. of R. R.	....	Tr	0.4	3.2	20.2	22.0	18.8	3.6	26.2	5.4	99.8	159
85	Road cut	....	....	Tr	Tr	0.4	0.2	1.0	0 4	53.0	45.0	100.0	294
86A	Road cut	....	Tr	0.6	1.4	3.2	1.8	2.2	1.8	56.8	32.2	100.0	269
86B	Road cut and auger boring	....	Tr	Tr	0.2	0.4	0.8	1.8	1.8	66.6	28.4	100.0	289
87	Road cut	....	Tr	Tr	0.4	2.2	2.6	5.2	5.0	68.6	15.8	99.8	271
88A	Road cut	....	....	Tr	Tr	0.2	0.4	1.0	0.6	62.8	34.8	99.8	295
88B	Road cut	....	....	Tr	0.4	2.2	2.4	4.0	3.8	63.8	23.4	100.0	273
89	Road cut	....	....	Tr	Tr	0.2	0.2	0.4	0.2	52.4	46.8	100.2	297
90	Road cut	...	Tr	0.8	3.0	8.8	7.0	9.4	6.2	29.8	34.8	99.8	200
91	Road cut	Tr	0.2	2.4	8.8	24.8	11.8	7.0	0.4	16.2	28.4	100.0	131
92A	Road cut; much organic matter	Tr	Tr	1.8	6.4	18.4	9.4	5.6	1.8	19.2	37.2	99.8	152
92B	Road cut	.	Tr	1.0	4.4	8.8	5.2	3.0	1.6	25.6	50.2	99.8	198
92C	Road cut	Tr	0.4	3.6	12.8	34.8	19.4	12.4	5.6	4.8	6.2	100.0	97
93A	Road cut	....	Tr	1.2	5.4	15.0	9.0	5.8	2.2	29.6	31.8	100.0	182
93B	Road cut	....	Tr	0.6	2.8	8.0	4.8	3.2	1.2	40.8	38.4	99.8	230
94A	Road cut	Tr	0.4	4.8	16.8	38.4	16.2	8.8	2.0	5.6	7.2	100.2	93
94B	Road cut	Tr	0.6	5.8	18.4	40.4	15.4	8.0	2.6	4.2	4.6	100.0	88

TABLE 13—

Sample number	LOCATION: County	LOCATION: Town near	LOCATION: Section ¼	¼	¼		LOCATION: Township	LOCATION: Range	Thickness sampled Ft.	in.	OVERBURDEN: Thickness Ft.	in.	OVERBURDEN: Material[1]	Underlying material[1]
95A	Mason	Mason City	NE	SE	NE	12	20 N	6 W	2	6		6	Soil	95B
95B	Mason	Mason City	NE	SE	NE	12	20 N	6 W	3		3		95A and soil	95C
95C	Mason	Mason City	NE	SE	NE	12	20 N	6 W	2		6		95A, 95B, and soil	Slightly calcareous sand
96A	Mason	Mason City	SE	SW	SE	2	20 N	6 W	3		1		Soil	96B
96B	Mason	Mason City	SE	SW	SE	2	20 N	6 W	3		4		96A and soil	Calcareous sand
97A	Mason	Teheran	NE	SW	SE	33	21 N	6 W	2		1		Soil	97B
97B	Mason	Teheran	NE	SW	SE	33	21 N	6 W	1	6	3		97A and soil	Slightly coarser sand
98	Cook	Lansing	NW	NW	NE	2	35 N	14 E	4	4		6	Soil	Slightly calcareous sand
99	Grundy	Coal City	NE	NE	SE	29	33 N	8 E	3			6	Soil	Pebbly sand
100	Grundy	Coal City	SE	SW	NW	29	33 N	8 E	5		1		Soil	Shale
101	Grundy	Coal City		SW	cor.	12	33 N	8 E	1	6		6	Soil	Calcareous clayey silt
102	Grundy	Coal City	NW	NE	SE	24	33 N	8 E	2			6	Soil	103
103	Grundy	Coal City	NW	NE	SE	24	33 N	8 E	2		2	6	102 and soil	Calcareous medium sand
104	Will	Wilmington	SW	SW	SW	26	33 N	9 E	2			6	Soil	Not exposed
105	Will	Lockport	SW	SW	SW	12	36 N	10 E	1	3	2		Soil and clay	Calcareous sand
106	Cook	Thornton	SW	SW	SW	35	36 N	14 E	2			6	Soil	Not exposed
107	Grundy	Minooka	NE	SE	SW	16	34 N	8 E	4			6	Soil	Not reached
108	Rock Island	Sears	NW	NE	SW	14	17 N	3 E	9			6	Soil	Calcareous sandy silt
109	Cook	Calumet City	NW	SW	NW	18	36 N	15 E	5		......		....	Not exposed
110	Cook	Lansing	SE	SW	NE	31	36 N	15 E	6		......		....	Not exposed

[1]Where the overburden or underlying material has been sampled and a sieve analysis is available, the number of the sample is given.

"Same" in the column "Underlying material" means that the material underlying the sample is the same as the sample, the sieve analysis of which is given on the opposite page.

Concluded

Sample number	Remarks	Sieve analysis, per cent retained on sieve											Grain fineness number
		30	40	50	70	100	140	200	270	Pan	Clay	Total	
95A	Road cut	..	Tr	1.6	9.4	38.6	19.8	8.4	0.6	9.2	12.2	99.8	106
95B	Road cut		Tr	1.8	10.0	49.8	21.6	9.2	0.2	3.6	4.0	100.2	90
95C	Road cut and auger boring	Tr	0.2	2.8	14.6	53.0	18.4	5.8	1.0	1.4	2.6	99.8	80
96A	Road cut	Tr	0.2	1.2	4.8	15.8	12.6	12.4	6.8	22.2	23.8	99.8	163
96B	Road cut	.	Tr	1.2	4.0	13.4	11.2	14.4	8.2	35.6	12.0	100.0	189
97A	Road cut	Tr	0.4	2.8	9.4	26.8	12.0	6.2	2.4	17.8	22.2	100.0	133
97B	Road cut	Tr	0.4	3.0	8.8	24.6	10.4	5.8	1.4	20.6	25.0	100.0	141
98	Ditch along road	Tr	0.4	0.4	1.0	14.2	53.0	16.2	1.0	4.6	8.8	99.6	113
99	Claypool ditch	...	....	15.2	16.2	17.2	5.6	2.2	2.8	10.8	29.8	99.8	104
100	Strip-mine cut	...	....	17.4	22.4	36.2	8.0	1.8	3.2	3.2	7.4	99.6	76
101	Auger boring	...	...	2.2	0.6	1.2	1.2	2.4	1.8	31.2	59.4	100.0	255
102	Strip-mine cut	...	....	11.8	19.6	40.2	13.0	5.0	0.8	2.4	7.0	99.8	77
103	Strip-mine cut	...	....	14.8	23.4	41.8	11.6	2.6	1.6	1.0	3.0	99.8	71
104	Road cut	...	1.2	10.4	18.4	40.8	13.8	4.8	1.0	3.2	6.0	99.6	79
105	Road cut N. of creek; small deposit	...	....	Tr	1.0	19.8	27.6	18.2	9.6	9.8	14.0	100.0	135
106	Ditch at road T.	...	....	7.0	9.4	34.0	23.4	12.0	2.0	5.0	7.2	100.0	98
107	Auger boring	...	....	12.6	11.6	28.8	21.6	4.2	5.4	3.4	12.0	99.6	91
108	Molding sand pit; calcareous	...	....	....	Tr	0.4	0.8	0.6	4.0	78.4	15.6	99.8	291
109	Small pit	...	Tr	1.6	3.3	68.3	24.2	1.6	0.1	0.4	0.5	100.0	78
110	Small pit	Tr	0.8	6.2	31.6	46.1	12.2	1.5	0.1	0.5	1.0	100.0	67